SILICON CHIP

MAY 2011
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Is your ADSL speed slow?

CHECK YOUR PHONE LINE POLARITY

BUYING AND SELLING TECH STUFF ON eBAY

SPORT SYNC

Eliminate that annoying delay between sports commentary on radio and digital TV pictures

FREE with this issue:

Jaycar Electronics 30th Anniversary 2011 Catalog

2011 ENGINEERING CATALOGUE OUT NOW

Full of great and exciting NEW products & old time favourites so grab a copy now!!!

Want a free copy?

Place an order this May valued $30 or more via our website and we'll include a FREE copy of our bumper catalogue. You will need to ask though, just in case you've already snapped up a copy you won't want us to needlessly send another one!

Only $3.95 at Jaycar stores & Stockists

- 508 PAGES
- 625 NEW PRODUCTS
- 6,950 PRODUCTS

CELEBRATING 30 YEARS OF SERVICE

NATURE ANATOMY MODELS

A fantastic educational tool for teaching how the internal structure of various animals and plants are different to our own. Each model comes complete with instruction booklet and display stand so you can preserve them for future study. Ideal for schools or the junior biologist.

- Recommended for ages 8+

Frog Anatomy Puzzle $29.95 SAVE $5.00

Detailed display of the internal organs, muscle and bone structure for the common frog.

- 31 parts
- Approx 120mm long

GG-2390 WAS $34.95

Shark Anatomy Model $29.95 SAVE $5.00

Make your own miniature version of Jaws and see why Carcharodon Carcharias is the perfect killing machine and has survived for 350 million years.

- 20 pieces
- Finished model: 335(L) x 200(H)mm

GG-2392 WAS $34.95

Tyrannosaurus Rex Anatomy Model $79.95 SAVE $10.00

T-Rex was about 15 metres long and lived around 65 - 85 million years ago during the Late Cretaceous period. Build him piece by piece and find out how he managed to digest 230kg of meat per bite.

- 39 pieces
- Finished model: 570(L) x 23(H)mm

GG-2394 WAS $89.95

Plant Cell Anatomy Model $24.95 SAVE $5.00

Complete model of a single plant cell allowing you to see how the smallest parts of plants work.

- 26 pieces
- Finished model: 110(W) x 125(H) x 70(D)mm

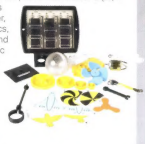
GG-2398 WAS $29.95

DELUXE SOLAR EDUCATIONAL KIT

A series of do-it-yourself experiments to acquire the basic knowledge of solar energy. Supplied with a solar panel which incorporates 3 x 1.5V cells for series or parallel connection.

- Kit comes with: solar cell module, musical unit, plastic lamp, DC motor, wire with motor clips, 4 jumper wires, nuts and plastic spanner, colour spinner discs, paper aeroplane and bird models, plastic discs and fan, and solar energy booklet.

KJ-6694



$29.95

6-IN-1 SOLAR EDUCATIONAL KIT

Build any one of six different solar powered projects from the parts in the kit. All the parts snap together so no tools, soldering or glue required. The instructions are excellent with extremely clear illustrations detailing every step. The finished projects are solar powered, but can also be powered by the light from a household 50W halogen light.

- Projects: windmill, car, dog, plane, airboat, and revolving plane
- Suitable for ages 10+

KJ-8926

BEST SELLER

$19.95

Animal Cell Anatomy Model $24.95 SAVE $5.00

One human being has over 100 trillion cells in their body. You won't have time to build that many, but you can build one to see all the parts that make it tick.

- 24 pieces
- Finished model: 115(W) x 160(H) x 60(D)mm

GG-2396 WAS $29.95

GIFT CARDS AVAILABLE IN STORE OR ONLINE

ROBOTIC KITS FOR KIDS

3-In-1 Solar Robot Kit

An exciting project that will keep the kids occupied for hours! This 3-in-1 solar robot kit easily transforms into three designs (tank, robot & scorpion). See how solar power drives the motor forcing these 3 robots to make different movements.

- Suitable for ages 10+

KJ-8928

$24.95

Solar Powered/Dynamo Robot Kit

Build your own solar powered robot. Moves forward and reverse. Supplied with a hand cranked dynamo for alternative power source. Hours of robotic fun.

- No batteries needed
- Recommended for ages 8+

KJ-8821

$29.95

Infrared Remote Controlled Robotic Beetle

The beetle is supplied as a kit of parts and once assembled, the beetle will scurry around and can pick up small objects with its controllable claw. It has forward and reverse drive capability and can be steered around obstacles. Suitable for ages 12+.

- Lifting robotic claw
- 100g lift capacity
- Requires 8 x AA batteries

KJ-8914

$49.95

All Savings are based on Original RRP

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Publisher's Letter

Nuclear power, LNG and coal fired power stations

What are the fundamentals for human survival? Most people would answer "Water, food, shelter and depending on climate, clothing". That is correct for mere survival but for normal everyday life, people would now add "electricity". People expect it as an absolute right. They become very anxious if a blackout deprives them of electricity for more than a few hours.

And rightly so. While people don't like being deprived of electricity for heating and air-conditioning, far more serious is food spoilage because the refrigerator or freezer is out of action. Nor can you cook, if you don't have a gas oven or barbecue. Add to that the lack of hot water for showers and you have a formula for serious discontent.

That discontent will be aimed squarely at government (even though the power generators may be in private hands). People pay for electricity and they expect a permanent supply. We all do, although we do make allowances for natural disasters.

So when there is a significant threat to power supplies, people do become very concerned. Now apart from my Publisher's Letter in the January 2011 issue on this topic, there has been very little coverage in the general media; so far. However, the whole eastern seaboard of Australia is running quite close to capacity and as far as we can tell, there is no significant new base-load power generation being planned. So what are we going to do?

I am just as opposed to coal mining and coal-fired power stations as anybody and have written Publisher's Letters on this topic years ago. My reason for opposing coal mining has nothing to do with carbon dioxide emissions and everything to do with its damaging of aquifers and productive farmland.

Mind you, that should not rule out expansion and upgrading of existing black coal-fired power stations. After all, the mines are in existence and so they should continue to work. What many people don't realise is that most of the NSW power stations are more than 40 years old; in fact, Wallerawang is more than 50 years old. They should be expanded and upgraded, with bigger turbo-alternators and super critical boilers which operate at steam pressures above 220 bar (3200 psi). Super critical boilers offer higher efficiency than the old super-heated steam boilers.

Just as an aside, because coal-fired power stations operate at much higher temperatures and pressures than nuclear power stations, they are much more thermodynamically efficient and those with super critical boilers are even more so. But as most people know, nuclear power stations do not create greenhouse gases. So they are desirable in that aspect but condemned on another – the nuclear bogey.

If coal and nuclear power are ruled out, as seems to be the case in Australia, and geothermal energy is as far away as ever, we have one option left for base-load power stations: gas-fired closed cycle. But again, state governments seem to be reluctant to actively do much about it, preferring to vacillate while the federal government confuses the entire country with moves toward a "carbon" tax which will penalise all power generators, whether they use LNG or not.

That is crazy. In fact, instead of a "carbon" tax the federal government would be better advised to subsidise the conversion of Victoria's old brown coal-fired power stations to gas-fired closed cycle generation. That would reduce their greenhouse gas emissions by two-thirds and probably do far more to reduce our national emissions than any tax formula.

By the way, in the aftermath of the Fukushima nuclear power disaster, Japan is going to burn more LNG – a great deal more. In fact, analysts have estimated that Japan could need as much as 20 million tonnes of LNG up until 2020, only nine years, to make up the shortfall from the closure of Fukushima and any delays to future nuclear plant construction.

That makes Australia's vacillation with power plant construction look plain silly.

Leo Simpson

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SOLARKING Monocrystalline 12/24/36V Solar Panels

Monocrystalline solar panels are designed for long life (up to 20 years) and high efficiency output. These units may be ganged into arrays for applications where high power output is required eg for large battery banks. An excellent solution for remote or mobile power applications, electric fence battery banks, inverter systems, RV's, caravans, boats etc.
All aluminium frames and tempered glass panels allow installation in the most demanding environments.
To prevent moisture ingress, the solar cell modules are laminated between sheets of high transmissivity 3mm tempered glass, tedlarpolyester-tedlar (TPT) material and sheets of ethylene vinyl acetate (EVA).

Stock#:	Max Power	Rated Voltage	Short Cct Curr.	Open Cct.	Dimensions LxWxH	Price
#36994	**10W**	12.0V	**0.56A**	22.0V	396 x 289 x 23	**$36.00**
#36995	**20W**	12.0V	**1.17A**	21.6V	645 x 295 x 25	**$69.50**
#36996	**40W**	12.0V	**2.28A**	21V	645 x 545 x 23	**$141.00**
#36997	**80W**	12.0V	**4.55A**	21.8V	1210 x 540 x 35	**$268.00**
#37873	**120W**	12.0V	**6.82A**	21.8V	1500 x 660 x 35	**$377.80**
#37970	**175W**	24.0V	**4.87A**	45.1V	1508 x 808 x 35	**$545.00**
#38653	**185W**	36.0V	**5.55A**	45.1V	1580 x 808 x 35	**$625.00**

Price Drop

Features:
*Heavy Duty Metal Frame
*20 Year Limited Warranty
*Monocrystalline Silicone
*3.2mm Tampered Glass

2000W Pure Sine Wave Power Inverters (with remote)

Specifications:
* Output Voltage 240VAC 50Hz
* Continuous Output 2000W (4000W Peak)
* Output Waveform Pure Sine Wave
* Harmonic Distortion <3%
* Full Load Efficiency >85%
* Wireless Remote Range 30M
* Dimensions 335x175x150mm
* Weight 6.0kgs

$466.50

#37965 12v
#38849 24v

150W Inverter With USB Charger

Continued Power: 150W (300W peak)
Dimension: 70 x 170mm
I/P Volt.: DC 12V (Cig. Soc.)
O/P: 220-240VAC
Modifield Sine Wave
O/P: 5VDCUSB

#38994 $25.00

SOLARKING 12V 110Ah GEL Deep Cycle Battery

Applications:
Solar and Wind Power Systems, Medical Equipment, Power Tools, Communication Equipment, Emergency Power System etc.

Rating: 12V 110Ah/10hr
Technolgy:GEL
Weight:31.85kg
Size(mm): 329(L) x 171(W) x 220(H)m
Manufacturer:Solarking

#38698

$265.0

Deep Cycle Batteries

Value regulated lead-acid batteries are designed with AGM (absorbent glass mass) technology, high-performance plates and electrolyte to gain extra power output for common power back up system applications. Widely used in the field of UPS, emergency lighting systems.

Features:
* Sealed and maintenance free operation
* Non-spillable construction design
* Safety valve installation for explosion proof
* Exceptional deep discharge recovery performance
* Low seld discharge characteristics

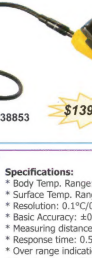
Applications:
* Solar applications
* Alarm Systems
* Security System

#38695	**12V 4Ah**	90(L) x 68(W) x 102(H)mm	**$17.50**
#38696	**12V 7Ah**	151(L) x 65(W) x 94(H)mm	**$22.80**
#38697	**12V 17Ah**	180 (L) x 75(W) x 165(H)mm	**$52.72**

3½ digit LCD 2 Channel Temperature Meter

Measurement range: -50° C to 1300° C (-58° F to 2000° F)
Resolution: 1° C or 1° F / 0.1° C or 0.1° F
Input protection: 60V DC or 24V RMSAC m

Display: 3½ digit LCD with maximum reading of 1999
Battery: Standard 9V battery
Battery life: 200 hours typical with carbon zinc battery
Dimensions: 147 (H) x 70 (W) x 39 (D) mm
Weight: 215g
Supplied probe: 4-foot type "K" thermocouple bead probe (teflon tape insulated). Maximum insulation temperature 260° C (500° F). Probe accuracy ±2.2° C or ±0.75% of reading (whichever is greater) from 0° C to 800° C.



$49.80

#39114

SMD Tweezer Test Probes For DMM

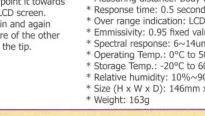
Identify those impossible to read SMD components! A handheld tweezer 'plug in' adaptor to suit just about any DMM. Permits on board or standalone testing of surface mount devices including resistors, capacitors, diodes, inductors etc (dependant on DMM functionality). Ideal for R&D, service centres, prototyping

length: 450mm

#37681 $12.50

3" LCD Borescope (inc. AV Output)

Features:
Model BS100
* Support real-time live view
* Support TV-OUT
* Highlighted with LED, to support the operation of the dark places
* Built-in 2000mAh lithium battery, support USB charging
* Standby function to support the charge
* Support rotating the image 180iã from top to bottom
* Support the OSD regulation of contrast, brightness, color temperature, etc. * Supports English and German.



#38853 $139.20

Specifications:
* Camera Sensor size: 1/4 inch CMOS
* Camera Maximum resolution: 640 x 480
* Camera Maximum frame rate(FPS): 30FPS/S
* Camera Color median: 24 Bit
* Camera Focus method: Fixed focus 15cm~ 25cm
* Gooseneck length: 1m(39")
* Camera diameter: 17mm(0.66")
* Color TFT-LCD size: 3.0 inch
* Display resolution: 960(W)X 240(H)
* Active area: 60mm X 45mm
* Adjustable light intensity level 6 Level
* Power Battery: Lithium batteries 3.7V/2000mAh
* Size:100 x 95 x 235mm

Non contact Body InfraRed Thermometer

Features:
* Non-contact Body InfraRed Thermometers
* Very simple to use, it reads the body temperature instantly and without contact. Thermoflash is particulary efficient for taking the temperature of newborn babies and very young children.
* From a distance of around 5cm, all you have to do is point it towards the forehead to read the temperature shown on the LCD screen.
* As there is no contact, you can immediately start again and again and as many times as you wish to take the temperature of the other family members without having to disinfect or change the tip.
* User Selectable °C or °F & forehead heat detection
* Select Body and Surface temperature
* Set alarm value and sound alarm
* Memorization of the last 32 measurements
* Automatic Data Hold & Auto power off

Specifications:
* Body Temp. Range: 30°C ~ 42.5°C / 86°F ~ 109°F
* Surface Temp. Range: 0°C to 60°C (32°F to 140°F)
* Resolution: 0.1°C/0.1°F
* Basic Accuracy: ±0.3°C at 30°C~40°C/86°F~104°F Range
* Measuring distance: Body temp.: 5-15cm
* Response time: 0.5 second
* Over range indication: LCD will show "Hi"/"Lo"
* Emmissivity: 0.95 fixed value
* Spectral response: 6~14um
* Operating Temp.: 0°C to 50°C (32°F to 122°F)
* Storage Temp.: -20°C to 60°C (-4°F to 140°F)
* Relative humidity: 10%~90% RH operating, <80% RH storage
* Size (H x W x D): 146mm x 104mm x 43mm
* Weight: 163g

#38464

$49.30

12VDC SMD LED Flexible Strips

Specifications:
* Width Strip: 8mm
* Operation Voltage: 12V DC
* Minimum cut size: 25mm
* Light source: 3528 Top LED
* LED Life time: 50K - 100K hours
* Applications: Indoor
* Viewing Angle: 120°
* Manufacturer: Dilux

Stock#	Colour	Price/metre
38255	**Warm White**	**$21.50**
38257	**White**	**$22.50**
38258	**Blue**	**$24.80**
38259	**Green**	**$24.20**
38260	**Red**	**$23.80**
38261	**Yellow**	**$22.80**

Features:
* Maximum bend diameter of 6cm
* Easy trimming to suit
* 3M double-sided tapes for affixing

Applications:
* Advertising Panels
* Demonstration cabinets

Slim Aluminum LED Bars(White)

Slim Aluminum LED Bar uses embedded 5050 LED chips, providing high brightness, low power and long lifespan lighting. With its modern design body, an innovative tilting angle feature makes it the best choice of illumination in application such as under cabinet, Cupboard, Store fixture, Wall Washer and Shelve illumination.

Specifications:
Light Source:5050 Top LED (3 Chips)
View Angle:120 deg.
Width of Strip: 14mm
LED Life time: 50K hours

Features:
* Two or more bars can be joined together
* Slim and modern design
* Tiliting angle capability
* Indoor application

Stock#	Length	Price
38757	**50cm**	**$37.40**
38758	**30cm**	**$25.30**

RGB 12VDC SMD LED Flexible Strip

* Width strip: 10mm
* Light source: 5050 RGB Top LED
* LED Life time: 50K - 100K hours
* Power Dissipation: 8W
* Viewing Angle: 120°
* Flexible, with a maximum bend diameter of 6cm
* Easy trimming to suit length and easy installation
* 3M double-sided tapes for affixing the strip

$36.50 *(per metre)*

Applications:
* Demonstration cabinets
** Use #38390 Controller **
* Decorative lighting in cafes, pubs, restaurants, and homes
#38389
* Manufacturer: Dilux

Remote Controller for RGB Light Strips

* RGB Light Strips can be set to one of seven different static colors or one of four different flashing patterns
* 12VDC operation with DC IN jack and +/- terminals
* Includes handheld RF wireless remote control

#38390

$58.50

6 Way Power Board with Individual Switches

Power Input: 240VAC 50Hz
Power Output: 2400W(Max)
* Rating: 10A 2400W
* Indicator Lamp
* Safety overload Protection
* 1 metre Main Cord
* 3 Outlets feature for extra wide space for bulky mains adaptors
Manufacturer.: SANSAI

#37461 **$12.50**

12VDC Solar Battery Trickle Charger

Lead acid cells will self-discharge, even when completely disconnected, if they are not re-charged regularly, eg. when a car is not driven for long periods or on a boat which is used infrequently. Includes suction cups for mounting to inside car windows, alligator clips and cigarette lighter adaptor lead.

$22.50 **#36450**

Non-Contact AC Test Probe & LED Torch

Easy operation allows detection of live wires without contact. Whenever AC is detected at a power point, sheathed or bare ended cable, the tester will light up red.

Features:
* AC Voltage detection without contact from 70-600VAC
* DC polarity check 1.5V-36VDC
* In-built LED light for working in dark areas
* CAT III 1000V rated
* Dimensions 176 x 26mmØ

#38127 **$12.50**

MR-16 High Power 6 Watt LED Light Cool White

Powered from either 12-24V DC or 12-18V AC making them well suited for use in caravans, boats, mobile homes and lighting displays. They are a direct replacement for standard MR-16 dichroic halogen lights & fittings.
LED life expectancy of >20,000 hours gives you 4 to 6 times greater reliability than conventional halogen globes.
Current draw ~500mA max.
3W light output. 65° light beam.

$26.88

Note: This version will operate with most switchmode transformers on the market.

#38848

Battery Charger (Inc. 4 x AA 2600mAH)

* Ideal for high-drain digital equipment such as digital cameras, camcorders and more...
* Charges 2 or 4pcs Ni-MH/ Ni-CD AA and AAA batteries
* -dV full charge detection & discharge function
* AC100-240V Worldwide Use
* Car Charger Adaptor and Switching Power Supply Included
* Includes 4 x 2600mAh High Capacity NiMH Cells

$22.00

#38040

SATLINK Satellite Meter

Features:
* Built-in Spectrum Analyzer
* LCD Colour Screen
* Bit Error Rate Readout
* Carrier to Noise Readout
* dBuV Readout
* Angle Calculator
* Lithium-ion 1950mA Battery
* DiSEqC & 22kHz Switch Control
* Live FTA Digital Picture and Sound
*Fully DVB Compliant

#38396 **$319.80**

Specifications:
Freq range: 950mHz-2150mHz
Signal level: 65dbm~25dbm
Symbol rate: 2mbps~45mbps
Video format: PAL/NTSC/SECAM
Software Upgradeable via USB
Size: 158 x 95 x 45
Manuf.: SATLINK WS-6902

Includes:
* 240v Charger Australian plug
* 12volt Cigarette Lighter Cable
* USB Cable & Strap

SATKING Digital Terrestrial Meter

Features:
* Digital Tuner
* LCD TV Colour screen
* Strength and quality readout
* Live digital picture
* Built in speaker
* 2.5 hours battery life
* Fully DVB MPEG-2 compliant

Includes:
* 240v Charger
* Carry Case
* 12VDC cable
* USB cable
* Strap

#38126

Specifications:
Frequency range: 174 MHz ~ 820 MHz
Signal level: -65dBm ~ 25dBm
Guard Intervals: 1/4, 1/8, 1/16, 1/32
Modulation Mode: QPSK, 16/64 QAM
Size: 158x95x45mm
Manufacturer: Satking WS-6905

$195.00

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Series-connected DC motors are practical for electric vehicles

Your reply to the letter from Clifford Wright regarding his ideas on an electric car ("Mitsubishi i-MiEV should have in-wheel motors", Mailbag, April 2011) leaves me rather puzzled. Firstly, you say "It is not at all clear that having two or more in-wheel motors, with a separate control system for each, is necessarily more efficient . . ." At no point in his letter did Mr Wright suggest using a separate control system for each motor. In fact he says that the increase in efficiency is from removing the need for a differential, and the consequent saving in weight.

Then you ask ". . . how can you connect the motors in series if you need them to run at different speeds when turning corners?" My guess is that you are thinking of AC induction motors. But Mr Wright's mention of "modern permanent magnet motors" and a "PWM control system" seem to imply the use of DC supply and motors.

As you are probably aware, two DC motors with permanent magnet fields, when connected in series, will have the same current flowing through each, giving approximately equal torque as a first approximation, while the voltage drop across each motor will be roughly proportional to its speed. This seems to meet the ideal characteristic for motors on each end of the driven axle of an electric car.

I do agree that motors within the wheels of an electric vehicle will increase the un-sprung weight to an undesirable amount. There are also the problems of reduced cooling air around the disc brakes, also of providing cooling for the motors and sealing them from the intrusion of water.

But by mounting the motors on the body of the car and using short driving shafts to the wheels, these problems could more easily be overcome. This is the system used in modern front-wheel drive vehicles and in rear-wheel drive vehicles with independent rear suspension.

G. D. Mayman
Dover Gardens, SA.

Comment: in practice, mainstream electric cars do not use permanent magnet motors; they use some variation of induction, synchronous or electronically commutated motors with variable frequency, variable voltage drive, together with regeneration for braking.

We agree that having permanent magnet DC motors in series may eliminate the need for a differential but that approach does not lend itself easily to regenerative braking, unless you use some sort of boost converter. While it is not our job to defend Mitsubishi, we assume that the big manufacturers have looked closely at a whole range of approaches.

Further explanation of series-connected DC motors

In the April 2011 Mailbag, Clifford Wright, of Helensville, NZ, wrote under "Mitsubishi i-MiEV should have in wheel motors" that he was "absolutely horrified by the terrible design" and suggested that using in-wheel motors wired in series was the proper approach because this completely removes the need for differentials. This drew the comment "By the way, how can you connect the motors in series if you need them to run at different speeds when turning corners?"

Now I, too, am absolutely horrified! The last time I looked, connecting two identical motors in series resulted in the same current flowing through each. This produces the same torque in each motor and if they are running at the same speed, the same voltage across each.

If one is slowed and the other sped up, as in a cornering situation, the current will stay more or less the same but the voltage across each will change due to the change in back-EMF. The outer motor will have to turn faster so the voltage across it will rise while the inner motor turns slower so its volt-

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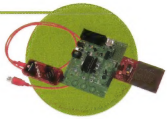

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Mailbag: continued

High mains voltage is common

Thanks for publishing my letter on high mains voltages in the March 2011 issue (Mailbag, page 12).

In reply to my letter, Brendan Falvey of Gundaroo (only a few kilometres from Canberra), in the April 2011 issue, assumes that I was referring to happenings of 30 years ago in Ainslie. Nothing could be further from the truth. The suburb was Forrest. Like Ainslie, it is one of the older burbs in Canberra but the time was only six years ago.

That the problem still exists, at least in the ACT, is evidenced by another organisation in the same geographic area as the church I mentioned recently being told that their voltage woes were their own concern! In other words, "fix it yourselves!" Seems I might have been lucky.

Mr Falvey also mentions Western Australia. In 1982, I was seconded to the ABC "Host Broadcaster" group, at the Commonwealth Games in Brisbane. The ABC, in a rare stroke of brilliance, brought TV OB vans from all over Oz to staff the venues. On arrival in Brisbane, the van from Perth had to re-jig its power systems. Set up for the 260V in WA, the van would not work at all on 240VAC.

The retrospective on ETI was most interesting. Way, way back, I built one of the first of David Tillbrook's "Black Monolith" amplifiers and a matching control unit. With the exception of one 5534 op amp failing a few months after building, it has performed flawlessly and still gets nice words from visitors on its "sound"; a tribute to really good design. Thank you ETI and its successor, for allowing the Tillbrooks of this world enough free reign to produce good stuff.

Thanks again for an always interesting magazine.

Bruce Bowman,
Airline ACT.

age drops. In fact, if you went to the extreme of stalling one motor, and if you ignored the resistance losses, the other motor would run at twice the original speed, just like a differential.

The situation is different if you connect the two motors in parallel. Now they will each have the same voltage applied and like all good motors, try to run at the same speed. They will share the current equally. If you now try to go around a corner, the slower motor would produce less back-EMF, resulting in it taking a larger share of the current and therefore producing more torque. Similarly, the faster turning motor will produce less torque.

This now means the two motors try their hardest to get back to the same speed resulting in a situation similar to locked differential – fine in a V8 super car but useless in a small road car. In fact, the situation is even worse in real life because no two motors are truly identical.

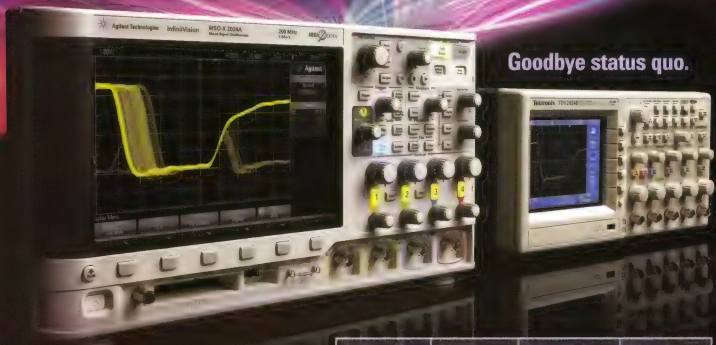
You can try this by simply wiring two similar DC motors together, first in series and then in parallel. In parallel, turning one results in the other rotating in the same direction, similar to a solid axle with no differential action. In series, they rotate in opposite directions, exactly like a true differential.

Those already involved in "mainstream" electric vehicles will be well aware of the many different approaches to electric drive. However, since you aim the magazine at the hobby and experimenter markets, they will mostly assume all motors for use on DC will be permanent-magnet commutator machines. That said, a great number of in-wheel motors use rare-earth permanent magnets, possibly because it is hard to achieve the same field strength with a wound coil.

Whether they use brushless commutation or not, they still behave much like a "conventional" motor. As for controlled regenerative braking and energy recovery from a permanent magnet motor, that is relatively easy using Mosfets and was described by International Rectifier back in the early 1980s to replace the previously used SCR circuits.

Read the review of the MSO-X 2024 4-channel oscilloscope in the April 2011 issue of SILICON CHIP

Hello future.



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Bandwidth (MHz)	70, 100, 200	50, 70, 100, 200	100, 200, 350, 500	100, 200
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Max memory depth	100 kpts	2.5 kpts	4 Mpts	1 Mpt
Max update rate (waveforms/sec)	50,000	200**	1,000,000	5,000
Fully upgradable	Yes	No	Yes	No
Function Generator	Yes	No	Yes	No
Notes:	**Refer to Agilent Pub 5989-7885EN for update rate measurements Data for competitive oscilloscopes from Tektronix publications 3GW-25645-0 and 3GW-22048-1 Measurements taken on same signal using Agilent MSOX3024A and Tektronix TDS2024B Screen images are actual screen captures and scopes are shown to scale			

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Mailbag: continued

Getting your hands on permanent-magnet DC motors to experiment with is a lot easier and cheaper than the exotic motors used in hybrid cars. The problem with series connection is that you need twice (or four times) the voltage and that will deter most people from the multiple motor approach. It is unlikely that anyone would attempt to fit a standard induction motor on each wheel.

John Jeffery,
Howrah, Tas.

Disagreement over hearing loop reference levels

With respect to the series of articles on hearing-loop systems (SILICON CHIP, September, November, December 2010, January & March 2011), I'd like to point out to John Clarke that the reference field strength level for induction loop systems is 400mA/m, not 100mA/m, which was stated in rather a misleading way in the first edition of IEC 60118-4. This has been corrected in the current edition (Ed. 2 2006) and includes a full explanation about the change. It is unfortunate that the work on the Australian standard was finished too late to take the new IEC edition into account.

Hearing-loop magnetic field strength levels are recommended to be at 100mA/m. This is for a 1kHz sinewave signal. The level for program material when measured over a long time period should equal this sinewave level. Therein lies the first problem. "Long term" is not defined. Since no-one talks forever, the limit level of speech is zero.

The program material is expected to vary by 12dB in level using a 125ms time weighting. Measured peaks will therefore rise to 400mA/m. Again, this is stated very confusingly in the standard. What it means is that the 125ms level may be 12dB higher than the undefined "long term" level. By "reverse engineering" this statement, using several samples of speech, it appears that "long term" is approximately a 60s average, certainly not the one-second average of the sound-level meter "S" mode.

So it's impracticable to measure the 100mA/m, because a meter with an averaging time of 60s responds so slowly. It's far easier to measure the 400mA/m level and far more relevant, since we need to know that a system is capable of producing this value, as hinted at in the old standard.

The 125ms averaging time is associated with a true RMS rectifier. This is a costly device, whether realised by discrete components or an IC. In the course of developing BS 6259 (now under revision), the use of a Peak Program Meter (PPM) rectifier was proposed. This is much less costly and works well, as the indication on the meter "hangs" on peaks (loud bits, not waveform peaks).

I am studying John Clarke's articles with considerable interest, because I wrote a similar series for Maplin Electronics magazine 20 years ago.

John Woodgate,
Rayleigh, UK.

John Clarke responds: we obtained the current standards [European standard IEC 60118-4 Ed. 1.0 (1981) and the Australian and New Zealand standard AS60118.4-2007.]

The important point is that while the IEC draft standards may have changed, the actual standards for signal level have not changed. It is not the full story to say that the hearing loop level standard has changed from 100mA/m to 400mA/m because this needs to be qualified. The changes really are only for the way that it is recommended to measure the signal level. So instead of measuring the level for

Politically-correct geiger counter needed

Given the extreme media paranoia here in Australia when talking about nuclear energy and the ongoing tragedy at Fukushima, isn't it time for SILICON CHIP to produce a 21st century geiger counter. It would of course have to use Green Energy to satisfy the Greenies, not use wool to satisfy PETA and have to recover and store all those nasties that it detects for recycling and to gain credits for the Carbon Tax.

Keep SILICON CHIP going; its an excellent production and the Publisher's Letters are priceless.

Arthur Lowe,
Mt Eliza, Vic.

Comment: what a wonderful idea! We particularly like the green flavour and the concept of capturing and storing all the nasties for recycling, presumably storing really long half-life nasties so that they are safe for our grandchildrens' grandchildren, etc.

the long-term average at 100mA/m, it is recommended to measure the peak signal level at 400mA/m.

So while the measured level is 12dB above the long-term average level, it is the peak level that is measured. Typical speech has peak levels 12dB above the long-term average and so the signal levels amount to the same, which ever way the measurement is made.

Currently, the Australian Standards still utilise the 100mA/m long-term average as the standard to set the hearing loop level. In my opinion, that is still the best way to measure the signal because a peak measurement is too signal dependent. Peak levels in speech vary markedly from the long-term average levels, depending on the person speaking, their voice frequencies and how they approach the microphone.

The changes to the IEC standard were made because of the confusion over what the long-term average period is. And incorrectly, it was assumed to be 1s rather than the 60s, as you state.

Our Hearing Loop Tester from November 2010 utilised a 1s averaging period for the 100mA/m measurement. As a result, we are now investigating some changes to the Hearing Loop Tester to reflect this improvement in the standards.

Incidentally, true RMS rectifier ICs are cheap and readily available. An example is the Analog Devices AD736.

Nuclear power should use Thorium

I refer to your Publisher's Letter in the April 2011 edition. You are certainly correct about those who oppose nuclear power. The Japanese earthquake and tsunami have most definitely caused a major setback for any organisation proposing this method of electricity generation, especially in Australia.

I recall scenes in Germany recently where the public were protesting against nuclear power and insisted that something be done, but what? They don't like coal-fired plants and typically renewable energy is expensive and not as consistent due to variations in, for example, sunshine and wind. It seems most of them undoubtedly have little understanding of how electricity is generated or how it gets to their homes. In a nutshell they don't like what they have but they can't

Praise for the DAB+ tuner

I've just flashed up the DAB+ tuner kit and wish to convey how good it sounds. In A/B listening tests with other digital and FM radios I own, the SILICON CHIP kit has obviously better low-end frequency response on digital and FM, as well as superior clarity on FM.

For the first time that I've heard, this unit makes DAB+ broadcasts sound better than the same program on FM. Thank you SILICON CHIP for a well designed project and thank you Jaycar for a comprehensive kit.

Tim Herne,
Calwell, ACT.

Mailbag: continued

Mains Moderator: another use with grid-feed inverters

I came up with a similar solution to the Main Moderator (SILICON CHIP, March 2011) for dropping the mains voltage for grid-feed inverters. With the mains at 250V, it is often enough to trip the over-voltage protection on the inverter. A suitably-rated transformer can be used as an auto transformer as you have here.

It was a revelation for me to realise that only the "secondary" has to be rated for the whole current, as the "primary" carries an appropriately scaled down current according to the turns ratio, just as it would if used in its standard application with the primary and secondary not joined. I can't say how many auto-transformers have been over-specified over the years for the whole winding to carry the full current.

Perhaps you may want to explain to readers how a similar set-up could benefit grid-feed inverters in high-voltage areas. We already have pretty high mains voltage where I live in suburban Perth so inverters made for the international market are already working at the higher end of their range.

Most inverters have a service menu where you can adjust parameters like these but the maximum permissible choice on the menu is still not high enough to prevent over-voltage.

Our grid regularly goes to 255V, usually late morning, with Western Power gearing up for the afternoon peak when everyone turns on air-conditioners. My grid-feed inverter played up from day one, even with the allowable voltage threshold set to the maximum.

Dennis Smith,
Perth, WA.

suggest an viable alternative.

Certainly, nuclear has a bad reputation in the public eye. One only has to think about Three Mile Island, Chernobyl and now Fukushima and plenty of arguments against nuclear gain some validity. However, I wonder why we are not seeing more nuclear plants that operate using another element I recently learned about: thorium.

If numerous websites are to be believed, thorium has many advantages over uranium. One tonne of it produces as much power as 200 tonnes of uranium and 3.5 million tonnes of coal. It is much more abundant than uranium. It comes out of the ground without the need for enrichment. It cannot be used for nuclear weapons. Radioactive waste can be fed back into the process to fuel the system and by design, there's no chance of a meltdown. Australia has 19% of the world's resources of thorium and in fact, this is not even a recent discovery. Russia, India and China have plans to use thorium in new plants but Australians, it would seem, are unlikely to give it half a chance due to radiation phobia.

Instead, Australians focus on solar, totally forgetting about its lack of ability to generate electricity in the dark or inefficiency on cloudy days, hence requiring coal and gas as a back-up. The exception to this might be the Concentrating Solar Thermal system featured in the August 2010 edition of SILICON CHIP, which provides base-load power and which very few Australians would be aware of. I wonder if we'll ever see any plants here using that technology.

Goodness knows we've got the real estate to take advantage of it. Such a system would reduce "carbon pollution", something those in power want to be seen to be doing, though in order to do that I'm sure they would much rather put a tax on carbon than spend money to prevent it in the first place.

Luke Biddle,
Murrumbidgee Waters, Qld.

TV aspect ratio is rarely correct

I worked in the television industry for 38 years and was partly involved in the conversion from analog to digital. Now I'm retired and enjoy the amazing quality of high-definition TV.

When I travel overseas and in Australia I'm constantly disappointed at the poor quality of the TV reception in hotel rooms, holiday accommodation, aircraft and all manner of televisions I come across while travelling.

What stands out most is wrong

aspect ratio. There is the latest widescreen TV showing digital images but in the wrong aspect ratio and no one seems to notice or care. Complaints to the providers of the TV go nowhere. Comments like "looks OK to me" or "it has always been like that" or "we get poor TV reception here" are typical.

Our latest holiday was to Darwin, which has digital TV. The accommodation in Darwin had widescreen TVs with a dynamic aspect setting that stretched the sides of the picture while the centre was normal. I could not change the setting as that part of the remote control had been physically removed. Attempts to have the hotel change the aspect setting got nowhere. Channel 10 in Darwin had no sound for over a day.

When I complained I was told that is not so bad, the receptionist had not had sound on channel 9 for several weeks! And the real problem is that "the TV transmitter is way out of Darwin". I pointed at the TV tower which was only 2km away in Darwin city. "Really" was the reply.

One place we stayed at in the Northern Territory had poor all-round TV. It is the usual feed that mixes free-to-air TV with satellite and in-house signals that are modulated onto an analog RF carrier. The results are usually awful. When I complained I was told that the TV transmitter is a long way

Australia does have a tsunami risk

In response to your editorial "Nuclear Power Now Not Likely In Australia" in the April 2011 issue, you mentioned that Australia is not subjected to severe earthquakes and tsunamis. This is quite wrong. Australia is subject to small to moderate earthquakes but directly across the "ditch" is New Zealand which is subject to very severe earthquakes which can generate very large tsunamis.

On the west coast of the South Island of New Zealand the beaches have large steps. These have been caused by earthquakes uplifting the west coast by 3-4 metres in a single event. These uplifts are very visible around Hokitika where they have been mined for gold and there is a very nice glow-worm grotto where one has been eroded by a stream.

There was a puzzle with large marine boulders found inland in NSW and the only explanation was that the transport of these boulders was actually caused by a tsunami caused by one of these New Zealand earthquakes.

So Australia is not safe. The current practice is to build nuclear reactors around the coast to provide easy access to cooling water. In Australia for economic reasons this would normally mean a reactor would be built somewhere near Melbourne and Sydney. But both of these are within the range of any tsunami generated from a large New Zealand-based earthquake.

Laurens Meyer,
Richmond, Vic.

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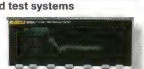

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Transferring 8mm film to DVDs

The big headline in the April 2011 edition, "Convert Your Movies Before It's Too Late" caught my attention.

I have a large collection of movies from 1970-1980. Most were taken at 18 or 24 fps for playback via sound projectors with constant speed at selectable frame rates, so I have no need for the described speed controller.

My main concern is whether DVD media outlast 8mm safety film. Certainly the colour dyes will fade over the years in the film but then I have had burnt DVD media that is unreadable after only one year.

I currently use Verbatim DVD media as it seems to be the best at retention of data. The best archive time I have been able to prove is five years. The cheaper brands of DVD media do not seem to have a long lifetime.

The speed that the DVD media is burnt seems to be an issue as well. I only burn at x4 with single-layer media and x2.4 with dual-layer media.

I can only assume that the longer the DVD dye layer is subjected to heat from the writing laser beam the greater the optical contrast between burnt digital 0s and 1s.

Robert Scott,
Waratah, Tas.

Comment: the life expectancy of some cheaper DVDs does seem questionable. However, film will definitely deteriorate. We would not suggest throwing out your movies once they have been converted but doing nothing is not practical.

away. When I pointed to the TV tower, which, if it fell it would have landed on the hotel, the reply was "Really is that what that is"!

Another example was in the Qantas lounge at Darwin airport. The widescreen TV had the right aspect ratio and was showing a widescreen program but the TV had been set to have the sidebars on regardless. So the widescreen picture was cropped.

It is a real pity that we have a fantastic digital TV system and yet 95% of the TV presented outside our homes is bad and almost always with the wrong aspect ratio.

I believe the problem is with those that install the systems and fool the management that that is as good as you can get, when it really is just shoddy workmanship.

Will McGhie,
Gooseberry Hill, WA.

Comment: the same comment can be applied to the TVs in clubs and pubs and with those there really is no excuse because clubs usually have some technical people who should know better.

It has almost got to the stage where anyone travelling might consider taking their own small digital LCD TV set in order to get reasonable reception. Or just "chill out" and you will enjoy TV even more when you return home from your holidays.

Power factor correction not a benefit to consumers

Power factor correction at a load's terminals does reduce power. By reducing the amps through the wires from the meter to the load, the losses in the wires (amps squared times wire resistance, as per Ohms law – and which heats the wires) will be reduced, so less power flows through the meter.

It may not amount to much but there is a saving of wire losses, which do not do any useful work, just heating up the surroundings (not useful in summer).

This is Power Electrical Engineering 101 stuff; or see the Westinghouse Transmission and Distribution Handbook.

John Zanello,
Victoria Park, WA.

Comment: power factor correction does reduce transmission losses – there is no argument here. However, power factor correction does not save power as far as consumers are concerned, since they are not billed for reactive power consumption.

Battery charger timers: electronic or mechanical?

In the Circuit Notebook section of the April 2011 edition of your much-read magazine, a contributor outlined an adjustable timer for controlling a battery charger. This unit proposed the use of a PICAXE processor and an extensive circuit but had timing graduations of one hour.

This, he suggested, was preferable to using a mechanical timer with its "little plastic keys".

However, I suggest that if you want a 240VAC adjustable countdown timer having a range of 0-4 hours, with time graduations of less than 5 minutes, trot along to your Bunnings store. You will find in their electrical section a HPM "4-hour countdown timer" (product number D812COUNT4). This will cost about $13.50. This unit does not have plastic keys and is very easy and quick to set.

Mechanical timers have an advantage over electronic units for battery charging applications, namely, when there is a power interruption, the electronic unit will stop and on reconnection of the supply, reset to "start" mode, and you will not know if the batteries have received their planned charge or not. The mechanical timer, on the other hand, will simply resume its task of timing the preset charge when the power is reconnected.

Many years ago I modified a standard mechanical timer by changing the timer motor supply from the power inlet side of the switch to the outlet side. This meant that the timer would only run when it had switched on, and latched off at the end of the timing period. The unit now acted as a countdown timer with a range of about 23 hours, with about 15-minute resolution.

Anthony Mott,
Blackburn, Vic. SC

Incorrect style with technical units

Whilst the change from Roman numerals was a much-needed step forward, I assume SILICON CHIP's maverick presentation of technical units (eg, 24VA or 75Ah instead of 24 VA and 75 Ah as per the now all-but global convention) is a historical legacy associated with typesetting convenience – rather than a possibly more acceptable buccaneering approach.

Australian Standard AS1000-1970 and also a UN Standard specifies a space between the numerical value and unit symbol (that indicates a multiplier, even when the value is used in an adjectival sense),

But I do wonder at SILICON CHIP's refusal to go along with the standard. My experience is that it causes professional engineers still under 90 to doubt the validity of a work as a whole.

I'd be interested to learn your professional readers' views on this. I trust that the more feisty of the staff will at least resist the editor's seeming desire to perpetuate the past, by my suspicion of Leo demanding that future issues be presented in iambic pentameter (but hopefully not also in Old Norse).

Having noted that, it would be churlish not to thank Leo Simpson and his staff for their excellent presentation of the ETI story in the April 2011 issue.

Collyn Rivers,
Church Point, NSW.

Comment: we choose not to follow this silly standard since it hinders rather than aids understanding and comprehension. It also causes problems with typesetting and line-wraps unless each unit is carefully provided with a "thin space" (a requirement of the standard which is rarely actually followed).

Nor do we adhere to some of the standards for presenting circuit diagrams, for much the same reason – clarity. Government departments may adhere slavishly to such standards but then they are also responsible for the most incomprensible examples of communication.

If professional engineers doubt the validity of SILICON CHIP articles due to such a trivial point, then so be it. In any case, nobody consulted us when the standard was created. We would have put them right.

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- Ammonium Persulphate Etchant
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Selling tech stuff

Have you got a horde of old junk, er, good stuff, that is now taking up too much space in your home? Here's the good oil on how to get rid of it at the best price, by selling it on eBay.

Like most SILICON CHIP readers I started early with technology, becoming fascinated with photography and audio in my early teens. Also like most readers, I became a collector by default, reluctant to discard even the most insignificant accessory, reel, roll, player or plug.

My first tape recorder was a weighty mono Pyrox ¼-inch machine that ran at 7.5 ips (inches per second) with a microphone and line input that I used to good effect to record some historic 1950s broadcasts.

My first camera was a German-made folder, with a pin-holed bellows that delivered OK shots indoors but produced such a degree of flare when used outdoors that these days you would need a Photoshop filter to reproduce it.

I lost my first collectible camera, a hefty Graflex, when it was stolen from a Paris youth hostel around the corner from the Folies Bergere.

Without realising what was happening, I then embarked on a 20-year adventure regaining the cameras of my youth.

So, one Saturday in 1977, without much forethought, I placed a 2-line ad in the Sydney Morning Herald's classified advertising pages. The advert read 'Old cameras wanted by collector.'

The phone started ringing at 6.00am and didn't stop for two years.

I ended up with over 300 items: Bakelite box cameras, Kodak and Zeiss folders, stereo and panoramic cameras and viewers, boxes of Polaroid snappers, Russian knockoffs of German classics, TLRs, SLRs, plastic Dianas, a couple of Mickey Mouse cameras, Thornton-Pickard wood/brass and mahogany cameras, early lenses, cameras in the shape of a cake of soap, camera-shaped cap guns, camera ashtrays, a Luftwaffe Robot motorised camera etc. And only two Leicas. I avoided them!

This vintage Altec microphone might look like junk . . . but at the time of writing there is one on eBay with a starting price of US$900. I have one in my collection but it is one I will NOT be putting up for auction!

My aim was to assemble a collection. I had no intention of selling the cameras. And who'd buy them anyway?

Gradually becoming an obsession, I then also haunted charity shops, auction sales, suburban markets etc. Well into the 1980s Sydney and Melbourne had quite a number of old camera shops that took vintage trade-ins and then displayed them in their windows; these I also pestered.

For two years I begged and pursued the owner of a giant clockwork Cirkut camera (the ones that take photos 10 inch by six foot) until he eventually gave in. I later acquired two more in varying sizes.

Along the way I also picked up the odd tape recorder, turntables, hifi amplifiers, plus some broadcast microphones, piles of LP records, early 16-inch transcriptions of radio programmes. Just to fill in the holes!

Admittedly, I did have an obsession but not as bad as one collector friend who actually bought an entire house in order to acquire the collection stored within it! Then, in another frenzied acquisition, he hired a crane so that he could move a 6-foot process camera out of the fourth story window of a city building.

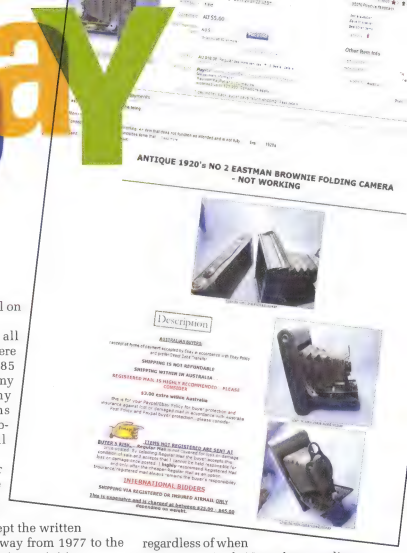
At one auction, I bid $50 on a mahogany box, decorated with brass fittings. Taking it home and digging into some early photo books (also acquired thanks to the SMH advert), I discovered it was a rare 1850s wet plate panoramic camera (without lens). A UK collector heard about it and offered me $20,000. A rare sale.

Sometimes the cameras found me. A Central Coast (NSW) junk shop owner called me to say he had acquired a gold Leica. Would I like to see it? Of course! It was bought for a tidy sum and later sold to an interstate collector within a fortnight for an even tidier sum!

There were times when I bought dear and when eBay came a-knocking, sold cheap! One example: a novel Foth-Flex twin lens/focal plane shutter reflex camera that I bought from a

on eBay

By BARRIE SMITH



Strand Arcade (Sydney) camera shop for the extortionate price of $189 in February 1978 and sold 30 years later on eBay for $62.

The sickness ended in the early 1980s, thanks to an overseas posting and a change in my marital status. The collection then moved to a storage facility, then to another home, ending up in our daughter's wall length wardrobe. And it sat there, until 2008.

What the hell to do with it? There really was no market, as far as I could see. Try eBay? Maybe, although I was wary of exposing myself on the world wide stage.

So my engagement with eBay started. My experiences may be of value to you if you're going to mix it with eBay yourself.

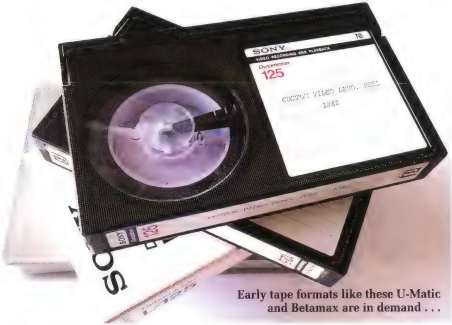
Capital gains tax?

Do you have to pay capital gains tax on items you sell on eBay?

For a start, all of the items were bought pre-1985 so, according to my accountant, any financial gains would not be subject to Capital Gains Tax.

Take care over this. In my case I had already logged every purchase and kept the written records, all the way from 1977 to the end of my obsessive activities.

Incidentally, the legislation covering Capital Gains Tax specifically excludes a capital gain or loss arising from the disposal of a "collectable" that was acquired for $500 or less, regardless of when it was acquired. Note that wording: "was acquired for $500 or less" – not what someone paid *you* for it. So even if you're lucky enough to buy a collectable for a dollar and sell it for a million, you *should* have no CGT problem. Also note the $500 applies to the value of the asset, not the taxpayer's interest in that asset.



Early tape formats like these U-Matic and Betamax are in demand . . .

Back to eBay

Launched in 1995, eBay itself started as a place to trade collectables

. . . as are old rolls of film by collectors wishing to "dress up" old cameras.

Early 20th century wood, brass and mahogany camera made by an unknown manufacturer for the London Stereoscopic Co; it has a replaceable stereo lens panel for 3D photography.

Cameras of this type, made by Sanderson and Thornton-Pickard sell for high prices — between $500- $1000 – on eBay.

and sundry items. Today it's a global marketplace where businesses and individuals can buy and sell practically anything. You can even sell your house on eBay. Would I? Not on your life!

To engage with eBay you first need to register at the eBay homepage (www.ebay.com.au/). Once you've completed the registration form you will receive a confirmation email from eBay to the email address you submitted during the registration process. Then you follow the instructions to complete your registration.

During the registration process, eBay will ask for your contact information (name, address and phone number) and email address. They declare that the service will not share your personal information without your consent.

To operate on eBay you need to choose a user ID and password. Again, a confirmation email will be sent to you. It is possible to have two eBay accounts, related to different email addresses and with two separate passwords. I have never seen the need for two accounts.

The eBay categories are numerous, ranging from antiques to video games. When you come to listing your item for sale, you can set up two listings; a dual listing I have found to be enormously useful but the trick is to select the 'right' pair of listings that will spread your item's fame far and wide.

An example: If you're selling vintage photos, I suggest you list the item under Vintage Cameras and Photographs.

You can set up the listing so that payment for the goods can be made to your credit card, direct bank deposit and PayPal. Of course, if you are happy to deal directly with the buyer, you can specify cash payment as one of the options. Some of the larger items may be so heavy you can't post them anyway, so a personal pickup is obviously the way to go.

I felt it wise to open an account for the financial returns and also for any payment that should be made to eBay, postage costs and dealings with PayPal (www.paypal.com.au/au).

PayPal is an enormously useful facility, not only for selling old cameras, audio equipment and suchlike, as in my case; I have also found it useful for buying on eBay.

When payment is made to you via

Neither a camera nor particularly old, nevertheless these 1960s 3D viewers (in original packaging and complete with 3D discs) are highly sought after.

Usually in demand are early box cameras, like this 1934 art deco Kodak. Sold for a disappointing $10. Bakelite box cameras bring higher prices.

This 1950s Japanese-made novelty is not a camera but a cigarette lighter. Sold for $34.

PayPal the deposit is shown near-instantly; at this point you can safely send the item to the buyer. I have also found payment by bank deposit to be reliable ... the only hangup is that you can only check that the money is actually in the bank on the next trading day.

When the funds are in your PayPal account you can transfer them to your bank account. This will take up to three days.

Let's start selling

Before you start your listing, you need to assemble some images of the item along with descriptive text.

For your own education, I suggest you scan a few current listings and get a feeling for what the other fellows and fems are doing online.

In 90% of the cases you'll find the entries are appalling, with poor images of the items for sale, along with minimal, misspelt accompanying text, laden with bad grammar.

Bad pictures lose you $$$

Let's start with the pictures. Too many sellers photograph their wares sitting on a tea towel or a busily patterned carpet. Not the way! Treat your eBay images like a shop window; top images will attract top auction bidding.

Digital cameras and eBay are a marriage made in heaven; even budget digicams can capture subjects large and small, with macro items and minuscule detail dead easy to photograph. With even the cheapest digicam you can capture a digital image that can show off your item to its ultimate advantage. Here's how I do it.

One of the trickiest subjects for me was the photographica: old mahogany/

Nor does it have to be a film camera: this Kodak DC-20 digital camera from late last century (OK, the 1990s!) sold on eBay recently for a disappointing $4.00 – about what it cost to list it!

Many of the photos you see on eBay are downright atrocious! Notice the difference here: same photo, but on the right you see only the item being offered. Use photo software to remove backgrounds, enhance and sharpen the image etc so the buyer can SEE what they are bidding on.

And if it has a case, show it! With many items, an original case can double or triple the value. If you want to show detail, take a couple of supplementary photos – they don't cost much to add on eBay but will certainly add appeal, interest and in the end, $$$ in your pocket.

brass/leather cameras; black and nickel folders; brown Bakelite box snappers. And early photos: prints; stereo cards; glass negatives of all sizes.

My technique in shooting an old camera was to set it up on a sheet of stationer's white card or, if the item was light in colour, against a grey card.

Lighting? I shot everything in the shade in an area that had a sunlit area to one side. Occasionally I would place a small white reflector beside the item to fill in any heavily shadowed area.

Never shoot anything in direct sunlight; after downloading the digital image you will be forever trying to correct the excessive contrast and unwanted shadows.

An alternative lighting setup is outside, under overcast (or at least cloudy) skies. You get a very nice even brightness on the subject. But make sure there is no "outside" background.

After downloading your pictures shot in the shade you'll get a shock at how drab and dreary they look, straight out of the camera. Software to the rescue!

I'm very fussy with pictures intended to display an auction item to its best advantage: it should be evenly lit to show off all detail and the sides, bottom and top should be square, with horizontal and vertical sides parallel. And sharp!

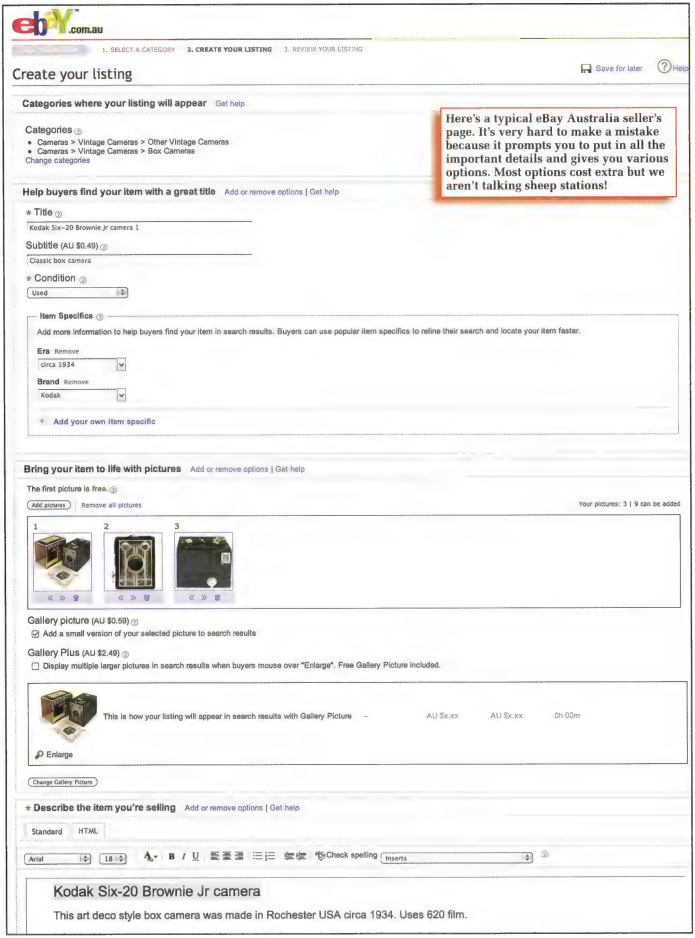
If you have any flavour of Photoshop you're in luck. (You can buy older versions of Photoshop [on eBay!] for peanuts). If you are a lesser being you may still be OK. There's lots of Photoshop-wannabes around – some even for free – and many of them are quite good.

The main requirements for your purposes are that you be able to alter the image brightness and contrast as well as a method of altering the shape of the subject, to square it off and correct perspective.

If it allows you to remove unwanted backgrounds (the technical term is "deep etching") so much the better.

With my trusty digicam I set it up at a reasonable distance from the subject,

LP records don't usually sell for much (if at all!) unless they have special features – an original autograph, a limited edition and so on. Old 78s often fare better but even better performers (pardon the pun) are 16-inch 1950s radio program transcription discs, such as those shown here. The rarer, the better! Old cylinder records aren't real bad, either.


ebay.com.au
1. SELECT A CATEGORY 2. CREATE YOUR LISTING 3. REVIEW YOUR LISTING
Create your listing
Save for later
Help
Categories where your listing will appear Get help
Categories
Cameras > Vintage Cameras > Other Vintage Cameras
Cameras > Vintage Cameras > Box Cameras
Change categories
Here's a typical eBay Australia seller's page. It's very hard to make a mistake because it prompts you to put in all the important details and gives you various options. Most options cost extra but we aren't talking sheep stations!
Help buyers find your item with a great title Add or remove options | Get help
* Title
Kodak Six-20 Brownie Jr camera 1
Subtitle (AU $0.49)
Classic box camera
* Condition
Used
Item Specifics
Add more information to help buyers find your item in search results. Buyers can use popular item specifics to refine their search and locate your item faster.
Era Remove
circa 1934
Brand Remove
Kodak
Add your own item specific
Bring your item to life with pictures Add or remove options | Get help
The first picture is free.
Add pictures
Remove all pictures
Your pictures: 3 | 9 can be added
1
2
3
Gallery picture (AU $0.69)
Add a small version of your selected picture to search results
Gallery Plus (AU $2.49)
Display multiple larger pictures in search results when buyers mouse over "Enlarge". Free Gallery Picture included.
This is how your listing will appear in search results with Gallery Picture
AU $x.xx
AU $x.xx
0h 00m
Enlarge
Change Gallery Picture
* Describe the item you're selling Add or remove options | Get help
Standard
HTML
Arial
18
Check spelling
Inserts
Kodak Six-20 Brownie Jr camera
This art deco style box camera was made in Rochester USA circa 1934. Uses 620 film.

I said earlier that LPs don't sell particularly well – but there are exceptions. Classic LPs can sell well, especially if they are original pressings. The rarer an item is, the more likely it will get a sale AND at a good price.
If you have some specific artist collections, don't be afraid to email fan clubs or collector's societies (use your old friend Google!) to let them know something special is being offered on eBay (even better if you tell them the eBay item number).

adding a touch of tele zoom in to help the shot's rectilinearity.

When preparing images for eBay display, the system will accept them in JPEG, BMP, GIF, PNG or TIFF formats. I use JPEG ... it does all I need. The size required by the system is that it be no more than 1000 pixels along the longer side and weigh in at no larger than 7MB.

Some advice: if you want to self host your listing, make each image no larger than 100KB and it will load quickly in the intending buyers' browsers. In my case, I used eBay's hosting, limited my images' size and introduced a touch of JPEG compression to keep the file size down.

Descriptive text: this is the clincher between an adequate and useless listing. If your sales item is a piece of technology, research it thoroughly, date its period and add data that will describe the item precisely.

You'll find Google an enormously helpful resource in accessing descriptive data about even the most arcane piece of gear. I also advise you to be accurate and honest in your description; you will face less trouble.

Listing

The eBay charge for each listing begins with a fee based on your starting or reserve price. Then there are add-ons.

If the item is eventually unsold you pay nothing; a Final Value Fee is paid, based on the final selling price. For example, an item that sells for under $75 will incur a fee of 5.25% of the final selling price.

You get a free image with each listing. You're allowed a total of 11 additional images for each listing and you pay 25c for each; there are options to display 'Supersize' images and you can opt for a Picture Pack of up to six or 7-12 pictures for $1.50 or $2.00.

You'll get a notice towards the end of the month informing you that the appropriate fee for your eBay activities will be deducted from your linked bank account on or about the seventh of the next month. Make sure the funds are in the bank account otherwise it gets messy!

Enter your details

First choose your category, then sub category and whether you want the listing to appear in one or two categories. You will be confronted by a series of panels, into which you add text describing the item in detail: condition, era, brand, descriptive text (on a test run I managed to insert 1000 words and there was still room for more).

Next, add your pictures. Decide which one should be your gallery picture that appears on the main listing.

You can also select one of the preset listings with fancy graphics and layout. Personally I find these of no use, merely adding clutter.

Set your starting price and take my advice: start low! Select what day and time you want to begin the listing as well as the auction period. You can also indicate a 'Buy It Now' price.

I suggest you be around during the period of the auction so that you can answer any questions intending buyers may throw at you via email.

I also made sure I was online in the final few minutes of the listing just to enjoy the fun and watch the competitive bidders fight for your goods!

You need then to indicate which payment methods you prefer: PayPal, bank deposit, cheque, COD etc.

The postage setup is interesting and shows how sophisticated the eBay engine is. You're required to indicate the size and final weight of the packed item and which method of postage will be used: there is a whole host of options but, in my case, I usually indicated Registered Post for domestic transport.

For overseas sales I opted for Express Post International ... with a rider.

If your package weighs under 2kg, there is an alternative registered

I "did me dough" on this TEAC 2300SX tape recorder. Despite being carefully packed and couriered (not posted) to the buyer, it arrived damaged – and I agreed to a $25 refund out of the $83 purchase price.

post method that is far cheaper than Express Post International: Air Mail Registered International. This is not recognised by eBay but will be welcomed by your customers.

And this is the rider I added to all my listings: *"My recommended shipping method for packages less than 2kg to overseas buyers is via Air Mail Registered International. For more info go to www1.auspost.com.au/pac/int_parcel.asp — or ask me for quote."*

When the prospective buyer visits your listing he or she can gain an estimate of the postage cost directly from the listing; eBay calculates postage based on the seller and buyer locations. Clever huh!

Finally, you can indicate whether you will provide a return service in the case of an unhappy buyer; I never did and in two years of eBay trading encountered only two disputative buyers.

At the close of all of this you will be notified of the final cost so far … and of course there will be a Final Value fee applied, based on the sale price.

Problem buyers?

The beauty of registered post — domestically and internationally — is that the buyer's pickup is tracked.

I had one turkey in the US who tried to tell me he had not received the package and wanted a refund: using the parcel's tracking code (printed on my postage receipt) I was able to enter the US postal system's online presence, discover what day and which post office the item was collected.

Problem solved! Silence from buyer!

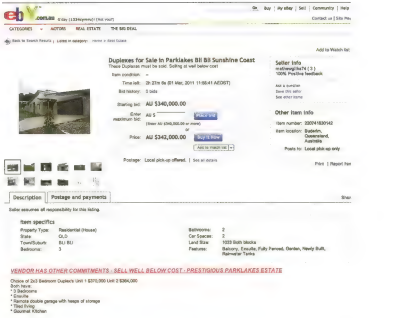
There were one or two other sticky moments, but the positive thing is that you can engage eBay to solve the arguments.

I lost only one tussle that necessitated my accepting an actual return, making a refund and silencing a vocal, abusive customer. On this occasion I found that the side that made the loudest noise won the game; eBay gave in easily.

I have noticed there are some eBay traders who will not deal with buyers from certain countries due to either dodgy buyer behaviour or untrustworthy postal services. In my experience it's not the countries who are dodgy but the occasional buyer!

You'll find there are many cranky Internet postings complaining about eBay and PayPal … some genuine and some spooky. Like this one: one customer bought a spice rack and a poltergeist in a package deal on eBay, then "paranormal and unexplainable things began to occur, like the sound of an elderly woman humming." You have been warned!

Want a new house? There's a variety of real estate being offered on eBay. But I'm not absolutely sure I'd want to part with $342,000 sight unseen, regardless of how fantastic the vendor makes it sound. Remember, despite eBay's buyer protection schemes, the rule is "caveat emptor"!



Con men get found out!

It's important to keep a clean face and impeccable trading presence … you're given a rating, based on after-sale comments by your customers. My own rating stands at near-five stars for accuracy of item's description, customer communication, time of outwards postage and reasonable postage costs.

I also found it important to pack each item very carefully and soundly, using piles of bubble wrap, cardboard boxes from the local supermarket, with brown paper exterior wrapping and clear addressing details.

There was only one occasion when an item fell afoul of poor handling. I sold a TEAC 2300SX ¼ inch tape recorder that weighed nearly 20 kilos to an interstate buyer. It consisted of recorder plus 29 reels of music and radio programmes, some commercially and some home-recorded, plus three takeup spools.

The TEAC was a nice piece of kit, recording onto twin stereo tracks at 3.75 and 7.5 inches per second plus two line and two mic inputs and two line outputs and a headphone output.

I was reluctant to post it, so the buyer arranged for a carrier to collect and deliver it to his address. At the time the package was collected I was unimpressed by the way the carrier handled the item. Then, four days later, the buyer emailed a polite complaint that the recorder had arrived with damaged wooden side panels. Would I refund part of the purchase cost?

Sale price: $83. I made a refund of $25, just to keep the peace and maintain my — so far — impeccable training record.

Washup

So, at the end of 18 months of selling in 77 batches, 99% of my collection has gone. With enjoyably high rewards.

Photographica of some vintage and with an inherent value bias — think Leica, Zeiss, Thornton-Pickard, Sanderson, stereo cameras and anything to do with Mickey Mouse — is highly saleable. Surprisingly, early Polaroid cameras are in demand. Remember those unwieldy clunkers?

In audio-video equipment, quarter-inch tape recorders, early valve amps, early microphones, early video and audio tapes, retro radios — think Betamax, U-Matic, 8-track — are attractive to the eBay hordes.

Don't bother with LP records, unless you have a genuine early Beatles album or similar, preferably an overseas pressing.

Looking back over the two years of my selling frenzy, I find that, while eBay and PayPal are far from perfect, they can be employed to dispose of your surplus goods.

But tread carefully! SC

Dick Smith - Your Comple

Weller
PSI-100K Butane Soldering Iron Kit
Pro grade butane tool with piezo self ignition, stainless steel body, complete with a range of high quality iron-plated tips and solid plastic case. Not carried in all stores, but can be ordered in. T3398

$128
SAVE $20

Dick Smith Temperature Controlled Soldering Station
Quality soldering station, slim 48W soldering pencil, 1.6mm long-life tip, cleaning sponge. Adjustable 150°C - 450°C temperature with front panel metering. Not carried in all stores, but can be ordered in. T2200

$59
SAVE $40

Purified Butane Gas Refill
Perfect for butane powered gas tools and products as well as most refillable butane lighters. Includes multi-adaptor nozzles to suit many butane-powered products. Propellant is an Ozone friendly hydrocarbon. Not carried in all stores, but can be ordered in. 150g can. H0946

$6.99

$12.99
SAVE $7

Dick Smith 60W Soldering Iron
Provides extra heat reserves for those larger jobs. With 240V operation, 470°C operating temperature, long-life plated tip, lightweight handle and a mini soldering iron stand. Not carried in all stores, but can be ordered in. T2309

THAT'S 1/2 PRICE

digitor
1.00mm 250g Roll 60/40 Solder
Suitable for use in high quality work requiring free running, low melting point solders, in electrical and electronic work generally performed by hand. 1.0mm, 250g roll. Not carried in all stores, but can be ordered in. N2619

$7.50

THAT'S 40% OFF

$98
SAVE $70

Dick Smith 1000A AC/DC True RMS Digital Clamp Meter
This industrial grade meter features a large 4000 count LCD screen with bar graph display, AC/DC current ranges to 1000A, and Auto Power Off function. True RMS AC voltage and current reading provide greater accuracy when measuring non-sine waveforms. Not carried in all stores, but can be ordered in. Q1476

$49.86
SAVE $30

digitor
Automotive Multimeter
Multimeter and automotive tester in one. Measure RPM, DWELL angle, current, temperature and more. Includes inductive pick-up, temperature probe, rubber holster and test leads. Not carried in all stores, but can be ordered in. Q1585

THAT'S 1/2 PRICE

Dick Smith Freeze Spray
Ideal for use in the electronic, automotive and engineering fields. It instantly cools small components to assist with detecting thermal problems such as faulty joints. 250g can. Non-flammable. Not carried in all stores, but can be ordered in. M1122

$8.48

THAT'S 1/2 PRICE

Dick Smith Contact Cleaner
An aggressive contact cleaner for use in cleaning metallic switch contacts in the general electronics area eg. TVs and older PCs. Not for use with plastics. Highly flammable. 190g can. Not carried in all stores, but can be ordered in. M1124

$7.49

Looking for your nearest Dick Smith store?
Head to dicksmith.com.au!

te Technology Destination

Dick Smith Lab Power Supply 0-30V 2.5A with Digital Display
Laboratory grade linear power supply with 0-30V adjustable output and an adjustable constant current setting from 0A to 2.5A at all selectable output voltages. Features separate voltage and current metering, overload protection and high/low current front panel terminals. Solidly-built chassis, measures 150mm (W) x 235mm (D, inc knobs) x 145mm (H, inc feet). Not carried in all stores, but can be ordered in. Q1770

$99
SAVE $50

Dick Smith Lab Power Supply 13.8V DC 23A
This solidly-built switch-mode power supply provides well regulated 13.8V DC output with a 23A current rating. Highly RF resistant, it is ideal for powering transmitters and other high-current loads in engineering and servicing applications. Features include an internal thermally switched cooling fan, heavy-duty DC banana terminals, a strong metal case, and extensive overload protection. Not carried in all stores, but can be ordered in. Q1755

$89
HOT PRICE

BELKIN. conserve
Insight™ Energy-Use Monitor
Monitor your power consumption with its easy-to-read display that shows how much devices really cost – in watts, dollars, and carbon emissions. M9972

$49.95

BELKIN. conserve
Smart Power™ Auto-Off Power Board
Detects when your TV or computer is turned on or off, and shuts down power to connected components, like video game consoles, DVD players, home theatre equipment, printers etc – so that no energy is wasted when the TV or computer is not turned on. M9973

$79.95

digitor
240V to 115V Step-Down Transformer 65VA
Ideal for equipment that runs on a lower power source. Converts 240V mains power to 115V. Rating 65W. Not carried in all stores, but can be ordered in. M1151

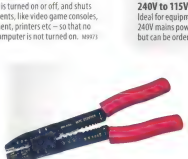
$79.98
SAVE $20

Screen Clene Wipes
Anti-static pre-saturated wipes suitable for all coated glass (including TFT and LCD screens) and polarising filters, such as screen filters and monitors. Non-flammable. Pack of 25. Not carried in all stores, but can be ordered in. N3317

$4.99

350pc Cable Tie Pack
Pack contains 100pcs each of natural and coloured 100mm x 2.5mm, 50pcs each natural and coloured 200mm x 2.5mm, and 50pc coloured 280mm x 3.5mm cable ties. Not carried in all stores, but can be ordered in. H5064

$7.99
SAVE $5



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This economical, high-quality crimper can strip various wire sizes from 0.75mm to 6mm, and crimp your cable quickly and reliably. Hardened steel for longer life. Makes fitting lugs and connectors a breeze. Not carried in all stores, but can be ordered in. T3525

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Cuts and strips cables as well as crimping various 4-pin, 6-pin and 8-pin modular connectors including 4P4C, 6P4C (RJ-11), 6P6C (RJ-12), and 8P (RJ-45) varieties. Rugged metal construction for accurate crimps. Not carried in all stores, but can be ordered in. T2923

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Talk to the Techxperts

SPORTSYNC
Audio Delay Module

By NICHOLAS VINEN

Many sports fans feel that radio commentary is better than that on TV, particularly commercial TV. To eliminate the annoyance of the TV commentary (and the adverts) they want to turn down the sound on the TV and listen to the radio instead. But the delay in the live TV broadcast causes a major problem. This simple project lets you delay the commentary on the radio to match the action on your TV – and it's remote controlled.

LOTS OF READERS have asked us for this project. They hate the commentary on TV sports broadcasts and the same comment goes for the adverts. But if they listen to radio commentary instead, they hear the score change before they see it on the screen. Our Sports Sync project fixes that.

It lets you to delay the radio from 0.2 seconds up to 30 seconds or more, in small increments. So it's perfect for matching up the sound and the picture.

A universal remote control is used to operate the device and the controls the Delay, Volume & Mute functions.

The rear panel of the device also carries an Output Volume control, along with an Input Gain Control and RCA input and output sockets. Three LEDs on the front panel indicate the device status: Power, Activity and Clipping.

Design

The obvious way to provide an audio delay is to convert the sound from the radio to a digital stream, store it in a memory buffer and then convert it back to analog audio later, ie, build a digital audio delay. By controlling how much of the memory buffer is used, we control the length of the delay.

The required memory buffer is quite large – larger than the amount of internal RAM (random access memory) available in any microcontroller. Even the new PIC32 series micros have an upper limit of 128KB of RAM which at a measly sampling rate of 16kHz and a low 8-bit voltage resolution is only enough to buffer about eight seconds worth of audio.

We want a longer maximum delay and better audio quality. So we need an external RAM chip for the microcontroller.

We considered the idea of adapting the SD Card Music & Speech Recorder/Player (SILICON CHIP, August 2009) for this purpose but it uses flash memory for storage and that is not suitable for this task. For this application, the memory is constantly being written but flash wears out after a fixed number

Audio delay lets you synchronise radio sports commentary with broadcast TV for the best of both worlds

of write cycles. In some cases the number of write cycles can be quite low so it is really only suitable for data storage.

RAM, on the other hand, can be written as much as necessary without any risk of failure.

The basic design is shown in the block diagram of Fig.1. The radio is connected to CON2 and its audio output is amplified and biased to suit the requirements of the analog-to-digital converter (ADC) in microcontroller IC1. The sound is then digitised and stored in a 512KB static RAM (SRAM) chip (IC2). It is later retrieved and played back, then passed through some filtering and a volume control before being sent to output connector CON3.

The incoming audio is also applied to a clip detector circuit consisting of a window comparator, pulse stretcher and clip LED. This indicates whether the audio gain is too high for the ADC so that the gain can be set to the optimal level.

The circuit also incorporates an infrared receiver (IRD1) which is connected to the microcontroller, so it can pick up remote control signals, providing delay and volume adjustment. An 8MHz crystal oscillator ensures that the delay and sampling rate are accurate and stable. Two additional LEDs (LED2 and LED3) provide feedback on the audio buffering state and infrared activity.

The two serial-to-parallel latch ICs (IC3 and IC4) assist the microcontroller in addressing its external RAM. Their role will be explained in more detail later.

Features & Specifications

Channels	1 (mono)
Delay	0.2-34s with increments starting at 50ms
Sample Rate	10-40kHz (see Table 1)
Voltage Resolution	12 bits
Input Sensitivity	200mV RMS
Signal-to-Noise Ratio	around -70dB
Controls	delay and volume adjustment (infrared remote)
Power Supply	9V DC 150mA

Software

The software which runs on the microcontroller has two main tasks: (1) record, buffer and play back the audio and (2) receive, decode and act on infrared control signals. The majority of the code is for the audio buffering scheme and Fig.2 shows how this works.

The audio signal applied to input

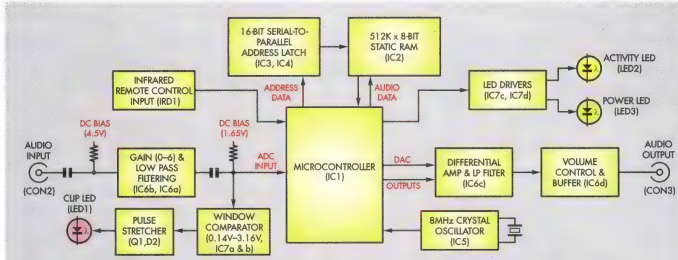


Fig.1: block diagram for the SportSync audio delay project. The incoming audio signal is amplified and filtered, then digitised in microcontroller IC1 and stored in SRAM (IC2). It is subsequently retrieved from the SRAM by IC1, converted back to analog audio and filtered and buffered before being sent to the output. A clip detector aids in setting the gain while two additional LEDs provide feedback. A universal remote control is used to operate the unit.

AN0 is continuously digitised and fed alternately into two 240 sample (480 byte) direct memory access (DMA) buffers. As each buffer becomes full, an interrupt is triggered and the handler subroutine moves its contents into the local circular recording buffer, which has space for twelve sets of 240 samples (12 x 480 bytes).

The local buffer blocks are 480 bytes each despite the 12 bit sample resolution. This is because the ADC stores each sample as 16 bits since that is the register size of this processor.

It is called a circular buffer because after data is stored in the final block, the next storage location is the first block again. This allows up to twelve buffers worth of data to be kept in the order that they are recorded without the need to move any of the blocks around in memory. Instead, we simply keep track of the first and last block to contain valid audio data.

As shown in the diagram, the local recording buffer typically contains only a couple of blocks worth of data. In reality though, it is larger than that to allow for any delays in being emptied (eg, due to infrared command handling), so that it won't overflow and lose data. It is emptied as quickly as possible into the main circular buffer, in the external SRAM chip. This can hold up to 1456 blocks of 240 samples.

When the data is moved to the external SRAM chip, it is re-arranged so that each pair of 12-bit samples is stored in three bytes rather than four (2 x 12 bits = 3 x 8 bits). Thus each 240 sample buffer takes up 360 bytes of SRAM. 1456 x 360 bytes = 511.875KB, so this just fits in the 512KB chip.

Once a block of recorded data has been stored to SRAM, another block is read back from a different location and fed into the local playback buffer. Like the local recording buffer, it also has space for twelve blocks of 240 samples but it is kept as full as possible. This is so that during a brief delay (eg, processing an infrared command), it will not empty.

The samples are converted back into the 16-bit format as they are transferred from SRAM into the local playback buffer. During this process, the digital volume control also takes effect. If the volume setting is below maximum, the sample values are re-scaled to a lower value, reducing the resulting audio amplitude.

Digital-to-analog converter

As with the ADC, the digital-to-analog converter (DAC) also has two 240-sample DMA buffers which it plays from alternately. As each buffer becomes empty, the DMA interrupt handler re-fills it from the local playback buffer.

The delay period is adjusted by controlling the difference between the location where data is fed into the circular storage buffer in external SRAM and the location where data is read back. If the playback location is not far behind the record location, the data does not spend long in the buffer before it is read back and so the delay is short. As the gap between the two locations widens, the delay increases.

Tape loop analogy

Just to make the workings of the circular buffer a little clearer, the circular buffer can be regarded as being similar to the analog delay systems which used an endless loop of tape with a recording head and replay head. In that case, the audio delay was set by the length of the tape loop, the tape speed and the space between the recording (input) and replay (output) heads.

In the digital system, we feed the signal into the circular buffer (which does not "move") and the microcontroller sets the delay by altering the space between the moving input address and the moving output address.

Sampling rate

The length of the delay also depends upon the sampling rate used (this is analogous to tape speed). The lower the sampling rate, the slower blocks are recorded and played back. So with a fixed number of blocks, at lower sampling rates the delays are longer.

However, lowering the sampling rate also reduces the audio quality (just as lower tape speed reduces the high frequency response and audio quality). So for short delays we want to keep the sampling rate as high as possible. Ideally, the sampling rate is reduced only when a longer delay is required

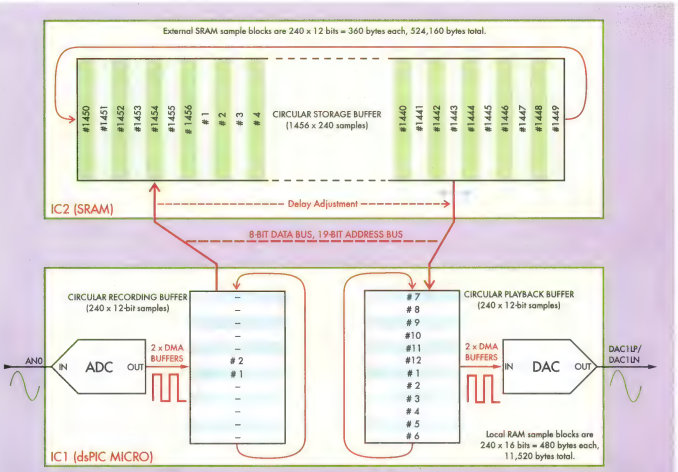


Fig.2: the audio buffering scheme. Digitised data is stored in a 12-entry local recording buffer and then transferred to the 1456-entry circular storage buffer within IC2. Later, data is copied back into the local playback buffer before being sent to the DAC.

than would otherwise be possible.

Initially, the sampling rate is set to 39.06kHz (40MHz ÷ 1024). This has a Nyquist frequency of 19.53kHz which is adequate for reproducing all audible frequencies of interest. In this condition, 240-sample blocks are consumed at the rate of 163 per second and so the maximum delay is around 1456 ÷ 163 + 0.1 = 9.03 seconds.

To keep the interface simple, we automatically lower the sampling rate if the delay is increased beyond eight seconds. When this transition occurs, the recording and playback rates are no longer equal so the gap between the recording and playback locations slowly grows and at the same time, the maximum possible delay increases. During this process, the green LED flashes.

The sampling rate is initially reduced to 26.04kHz (40MHz ÷ 1536), which allows for a maximum delay of 1456 ÷ 109 + 0.1 = 13.4 seconds. If the delay is set to more than 12 seconds then the sampling rate is reduced again. This process continues down to a minimum sampling rate of 9.77kHz (40MHz ÷ 4096) – see Table 1.

To aid in this process, the software keeps track of the sampling rate used to record each block stored (1480 total), allowing it to play back each block at the same rate as it was recorded. This is necessary because the playback rate only changes some time after the recording rate changes, ie, when the first block recorded after the rate change makes its way through all three buffers.

This means that at some point after the sampling rate changes, there may be a small glitch in the audio due to the sudden change in sampling rates. This only occurs once, until the sampling rate stabilises and it is usually innocuous.

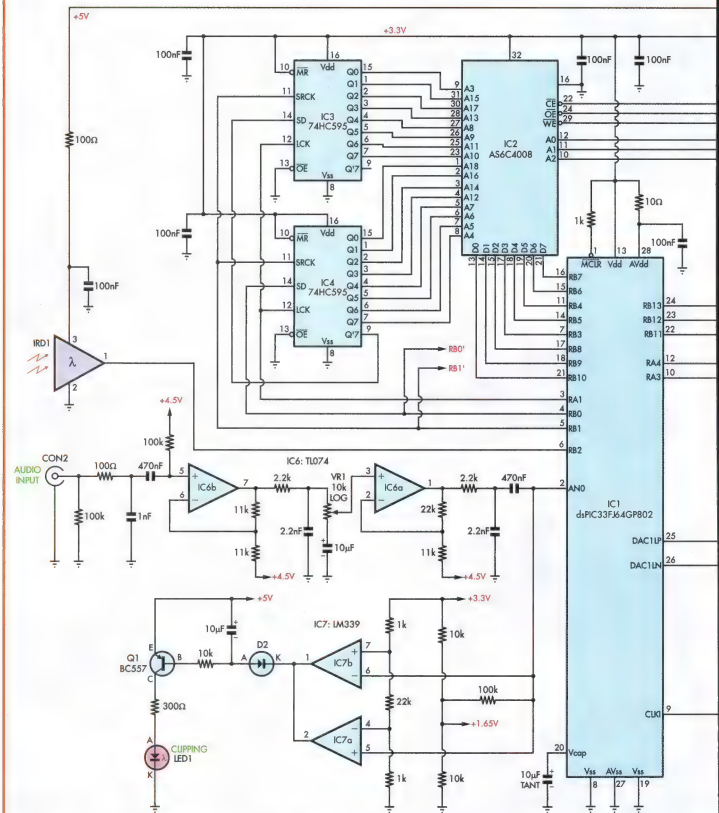
If the delay is reduced far enough to allow a higher sampling rate to take effect, the rate will automatically be increased using the reverse of the process described above.

Circuit details

Refer now to the complete circuit diagram, shown in Fig.3. The audio signal from the radio is applied to RCA connector CON2, with a 100kΩ

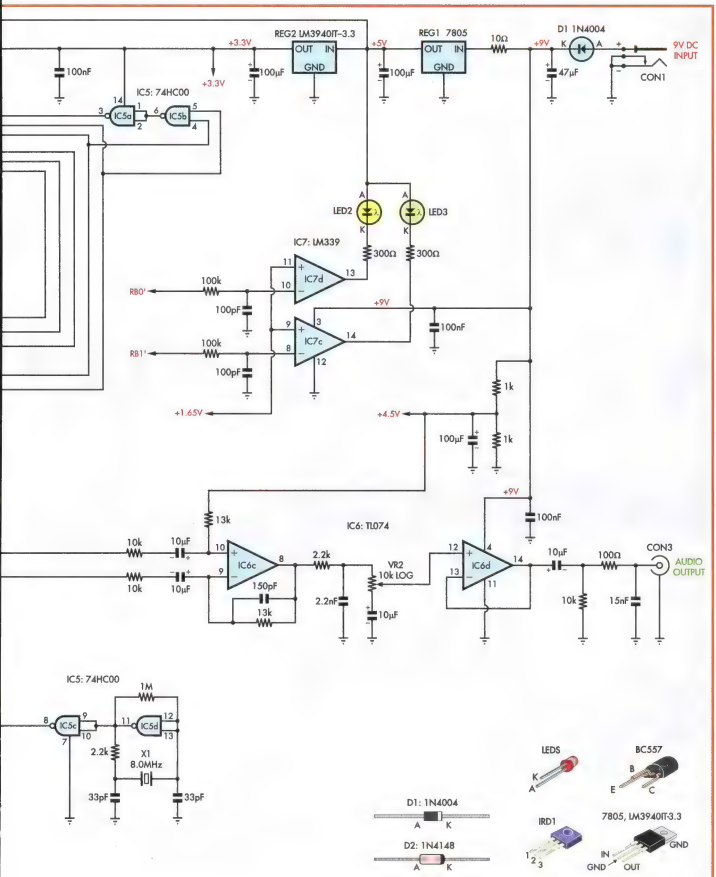
Table 1: Sampling Rate vs. Maximum Delay & Frequency

Sampling Rate	Maximum Delay	Switching Point	Maximum Audio Frequency
39.06kHz	9.0 seconds	8 seconds	19.53kHz
26.04kHz	13.4 seconds	12 seconds	13.02kHz
19.53kHz	17.9 seconds	16 seconds	9.77kHz
9.77kHz	35.7 seconds	–	4.88kHz



SILICON CHIP SPORTSYNC AUDIO DELAY MODULE

Fig.3: this is the complete circuit. The audio is delayed using microcontroller IC1 and static RAM chip IC2. Op amps IC6a-IC6d condition the audio input and output signals, while comparators IC7a-IC7d perform audio signal clip detection and drive the two status indicator LEDs. IC5c and IC5d form the crystal oscillator circuit which drives pin 9 of IC1.


REG2 LM3940IT-3.3
REG1 7805
OUT IN GND
+3.3V
+5V
+9V
10Ω
D1 1N4004
9V DC INPUT
CON1
100nF
100µF
47µF
IC5: 74HC00
IC5a
IC5b
LED2
LED3
300Ω
IC7: LM339
IC7d
IC7c
100k
100pF
RB0*
RB1*
+1.65V
+4.5V
1k
IC6: TL074
IC6c
IC6d
13k
10k
10µF
150pF
2.2k
2.2nF
VR2
10k LOG
15nF
100Ω
CON3
AUDIO OUTPUT
IC5: 74HC00
IC5c
IC5d
1M
X1
8.0MHz
33pF
LEDS
BC557
D1: 1N4004
D2: 1N4148
IRD1
7805, LM3940IT-3.3
IN
GND
OUT

Parts List

1 PC board, code 01105111, 118 x 104mm
1 ABS instrument case, 140 x 110 x 35mm (Jaycar HB-5970, Altronics H0472)
4 No.4 x 9mm self-tapping screws
1 9V 150mA+ plugpack (Jaycar MP3146, Altronics M8922)
1 universal infrared remote control (eg, Altronics A1012, Jaycar AR1726)
1 8MHz HC49 crystal (X1)
1 PC-mount DC socket (CON1)
2 PC-mount switched RCA sockets (CON2, CON3)
2 10kΩ logarithmic 16mm potentiometers (VR1, VR2)
2 small knobs to suit VR1 & VR2
3 5mm LED right-angle mounts
1 32-pin or 40-pin DIL socket
1 28-pin DIL socket
2 16-pin DIL sockets (optional)
3 14-pin DIL sockets (optional)
1 400mm length 0.71mm diameter tinned copper wire
Front & rear panel labels

Semiconductors

1 dsPIC33FJ64GP802 microcontroller programmed with 0110511A.hex (IC1)
1 AS6C4008-55PCN 512k x 8bit 3.3V SRAM (IC2)
2 74HC595 octal serial-to-parallel latches (IC3, IC4)
1 74HC00 quad NAND gate (IC5)
1 TL074 quad JFET-input op amp (IC6)
1 LM339 quad comparator (IC7)
1 infrared receiver (IRD1)
1 7805 3-terminal regulator (REG1)
1 LM3940IT-3.3 low dropout regulator (REG2)
1 BC557 PNP transistor (Q1)
1 1N4004 1A diode (D1)
1 1N4148 switching diode (D2)
1 red 5mm LED (LED1)
1 yellow 5mm LED (LED2)
1 green 5mm LED (LED3)

Capacitors

3 100µF 16V electrolytic
1 47µF 25V electrolytic
6 10µF 16V electrolytic
1 10µF 16V tantalum
2 470nF MKT
9 100nF MKT
1 15nF MKT
3 2.2nF MKT
1 1nF MKT
1 150pF ceramic
2 100pF ceramic
2 33pF ceramic

Resistors (1%, 0.25W)

1 1MΩ	4 2.2kΩ
5 100kΩ	5 1kΩ
2 22kΩ	3 300Ω
2 13kΩ	3 100Ω
3 11kΩ	2 10Ω
6 10kΩ	

pull-down resistor for DC biasing. Following this is a resistor/capacitor (RC) low-pass filter of 100Ω and 1nF, which eliminates any radio frequency (RF) signals picked up by the signal lead.

The audio signal is then AC-coupled with a 470nF capacitor and biased to half supply with a 100kΩ resistor. This nominally 4.5V half supply voltage is generated with a simple 1kΩ:1kΩ resistive divider and filtered with a 100µF capacitor, to remove any supply ripple. Biasing the signal to this level allows the op amps which process it later to have a symmetrical swing within the supply rails.

The signal is buffered and amplified by IC6b, one quarter of a TL074 quad low noise JFET-input op amp. The amplification factor is two, set by the two 11kΩ feedback resistors. This allows for an input signal of up to around 1V RMS before clipping occurs.

The signal then passes through another RC low-pass filter (2.2kΩ/2.2nF) with a -3dB point of 33kHz, to filter out any supersonic components of the signal. This reduces aliasing artefacts in the later analog-to-digital converter (ADC) stage which can result from signal frequencies above the Nyquist frequency (ie, half the sampling rate).

Following the second RC filter is potentiometer VR1 which allows the overall recording gain adjustment. This is important since we want the signal swing to be just below the clipping point for the ADC, to maximise dynamic range. The 10µF capacitor prevents DC current flow through the potentiometer due to the signal DC bias. It charges up to half supply via the potentiometer.

The resulting audio signal then passes through IC6a which is also configured as a buffer and gain stage. This time the gain is three ((22kΩ + 11kΩ) ÷ 11kΩ). It is followed by another 33kHz low-pass filter to further reduce aliasing. The -3dB point of the combined filters is around 21kHz.

The signal is AC-coupled and DC-biased again with another 470nF capacitor, this time to half the 3.3V supply, ie, nominally 1.65V. This half-supply rail is generated with another resistive divider, this time comprising two 10kΩ resistors. There is no filtering since this rail is regulated. The signal is applied to the AN0 analog input of IC1.

IC1 samples the voltage at AN0 at one of the above-mentioned sampling rates, depending on the delay setting. The audio is then later converted back into an analog signal by the internal DAC and appears at pins 25 and 26 of IC1 (DAC1LP and DAC1LN). The signal at pin 26 is inverted compared to pin 25 and we obtain the final audio signal by subtracting these two voltages, to reject any common distortion or noise.

This subtraction is performed by IC6c, which is configured as a differential amplifier. The 150pF feedback capacitor reduces amplifier gain at high frequencies for stability as well as providing some low-pass filtering to remove DAC switching noise.

The two 10µF AC-coupling capacitors allow the DAC output signal to be re-biased to the 4.5V half supply rail, so IC6c can operate correctly. The audio signal then enters another low-pass filter identical to those used earlier, to further attenuate DAC switching noise and then passes to the 10kΩ volume adjustment potentiometer. As with VR1, this also has a 10µF capacitor to prevent DC current flow through it.

The audio signal is buffered by IC6d (a voltage follower) and AC-coupled so that it is symmetrical about ground. It then passes through a third low-pass RC filter consisting of a 100Ω resistor and 15nF capacitor, with a corner frequency of 106kHz. This is deliberately high so that additional cable capacitance will not attenuate the high audio frequencies and the 100Ω resistor also provides output short-circuit protection.

Clip detection

The signal input to the ADC should be just below 3.3V peak-to-peak since

the ADC's resolution is limited. If the signal voltage is significantly less than the ADC's range, the resulting resolution will be less than the full 12 bits.

If the input to AN0 exceeds either of IC1's supply rails, the result contains unpleasant high-frequency clipping artefacts. The clip detection circuit helps the user maximise ADC resolution without clipping the signal.

IC7 is a quad comparator with open-collector outputs. Two of its stages are used to detect clipping. The audio signal is applied to the non-inverting input of IC7a and the inverting input of IC7b. Their outputs are connected together to form a window comparator.

The "window" is defined by three resistors, two 1kΩ and one 22kΩ, connected between the +3.3V rail and ground. The voltages on either side of the 22kΩ resistor are about 3.16V and 0.14V. If the signal voltage is outside this range, the output of one comparator goes low, pulling current through diode D2, charging the 10µF capacitor.

When this capacitor has charged, current flows through the 10kΩ resistor from Q1's base, supplying current to the clip LED (LED1), which is limited to 10mA by the 300Ω series resistor. The capacitor charges quickly but discharges slowly, ensuring the LED lights for long enough to be visible.

Memory interface

As explained earlier, we are using an SRAM chip to buffer the audio data. This is essentially a large array of 8-bit registers packed in a chip (524,288 registers to be exact). This makes it very fast and gives practically infinite rewrite cycles but it is significantly more expensive than dynamic RAM (DRAM). However DRAM is harder to interface with; see the adjacent panel for more details.

Interfacing with the SRAM chip presents some challenges. The AS6C-4008 has 19 address inputs, three control lines (write enable, output enable and chip enable) and an 8-bit data bus. That's a total of 30 inputs or outputs (I/Os). With the type of microcontroller we are using, we would have to use a surface-mount package to get enough pins to interface directly with such an IC.

To avoid this, we drive 16 of the 19 address lines (A3-A18) with two high-speed 74HC595 serial-to-parallel latch ICs (IC3 and IC4). The remaining three address lines (A0-A2) are driven directly from the micro. This means that we can read or write a block of eight bytes of data quickly and then to change blocks, we shift one of 65,536 possible block addresses into the serial latches.

Since the serial transfer can occur at the same time as we are reading or writing our 8-byte block, this doesn't slow down memory access. The new address is shifted into the latches by one of IC1's internal serial peripheral interface (SPI) units and when it is time to change the address, the LCK line shared by IC3 and IC4 is brought high, instantly switching to the new address.

Data transferred to and from the SRAM goes over an 8-bit bus (DQ0-DQ7) that is connected directly to eight consecutive pins in the micro (RB4-RB10).

To save another pin, we can control the three memory control lines using two microcontroller outputs. To write to the SRAM, we bring output RA4 low. This directly pulls input WE-bar (write enable) of IC2 low but it also brings CE-bar (chip enable) low via the AND-gate formed by IC5a and IC5b. Both of these inputs to IC2 must be brought low to perform a write operation.

Similarly, to read from the SRAM, output RA3 brings IC2's OE-bar (output enable) input low as well as the CE-bar (chip enable) input, via the same AND-gate.

All in all, we use three of IC1's pins to drive the serial address bus (RB0 for

SRAM & DRAM: What's The Difference?

Processors use two types of random access memory (RAM): static RAM (SRAM) and dynamic RAM (DRAM). SRAM is used where speed is critical, eg, for processor instruction and data caches, hard drive caches and so on. DRAM is used for bulk storage such as main memory.

SRAM is essentially just a series of registers, where each is formed from a number of CMOS transistors (ie, Mosfets); typically six are required per bit. This forms a bistable element and as long as power is applied, the memory state is retained. Because Mosfets consume most of their power when switching, idle SRAM power can be very low. When an SRAM is inactive its power consumption is almost entirely due to the gate leakage currents.

Since it is built from transistors, SRAM is also fast. Speed is limited primarily by propagation delays and transistor switching speeds.

On the other hand, data is stored in DRAM using small capacitors which are fabricated on a silicon die. In modern DRAM, these capacitors are typically built in "trenches" to increase density. The charge in each capacitor represents one data bit and each capacitor is normally accompanied by a single transistor which connects the capacitor to the data bus when that bit is to be read or written.

Because each DRAM cell contains just one transistor and one capacitor, DRAM density can be very high, so a single DRAM chip can store a lot more data than a similarly sized SRAM chip. There are three drawbacks to DRAM though: speed, power consumption and interface complexity.

Speed is limited because the capacitors take time to charge and discharge and because when reading DRAM, to avoid discharging the capacitor, the current drain must be kept low.

The DRAM interface is more complicated because the capacitors won't hold a charge forever. They eventually discharge via leakage. This means that DRAM must be constantly "refreshed" every 64ms or so. To refresh the RAM, essentially it is read and then re-written, topping up the charge on the capacitors.

Refreshing is an extra task which must be managed by the DRAM controller and it can't interfere with the normal operation of the memory, ie, it must be hidden from the processor (or else the processor has to be aware of it and work around it).

This is also the reason that power consumption is typically higher than for SRAM. The refresh circuitry must be constantly active, even when memory is not being accessed, and this means extra power consumption regardless of how active the memory bus is.

So when speed is critical, SRAM is used and when capacity is the dominant requirement, DRAM is the best choice.

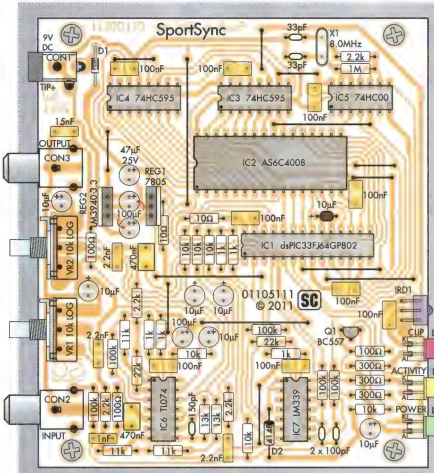
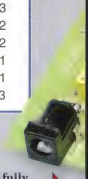


Fig.4: follow this parts layout diagram to build the PCB. All components mount on this board which fits neatly into a small plastic instrument case. Ensure that the electrolytic and tantalum capacitors, diodes and ICs are installed with the correct orientation.

Table 2: Capacitor Codes

Value	µF Value	IEC Code	EIA Code
470nF	0.47µF	470n	474
100nF	0.1µF	100n	104
15nF	0.015µF	15n	153
2.2nF	.0022µF	2n2	222
1nF	.001µF	1n	102
150pF	NA	150p	151
100pF	NA	100p	101
33pF	NA	33p	33



The view at right shows the fully built PC board. Take care not to get the two 3-terminal regulators (REG1 & REG2) mixed up and note that they face in opposite directions. Note also that there are a few minor differences between this prototype and the final version shown in Fig.4.

serial data, RB1 for the serial clock and RA1 for the latch control), three pins for the remaining address lines, eight pins for the data bus and two to initiate reads and writes, for a total of sixteen control lines. This leaves just enough free pins for the other functions we require, with some pin multiplexing.

Status LEDs

We use multiplexing to drive two status LEDs without the need for additional micro pins or external latches. Outputs RB0 and RB1 primarily drive the serial bus but when it is idle (which is much of the time), their state determines whether LED2 and LED3 are lit. The serial peripheral which drives RB0 and RB1 is switched off when it is not being used and each pin is held either low or high.

Because the serial bus is only being used a fraction of the time, the average voltage at the RB0 and RB1 pins is mostly controlled by their state between serial bursts. The voltage is averaged by two low-pass RC filters consisting of 100kΩ resistors and 100pF capacitors, with a -3dB frequency of 16kHz.

The voltage across these capacitors is compared to the 3.3V half supply voltage (ie, around 1.65V) by IC7d and IC7c. These drive LED2 and LED3 respectively, via 300Ω current-limiting resistors, setting the LED current at around 10mA. The LEDs are on if the filter capacitor voltage is above 1.65V, which is true only when the corresponding I/O pin is being idled in the high (+3.3V) state.

Power supply

The power supply is simple. Diode D1 provides reverse polarity protection and the following 47µF capacitor provides a small amount of filtering. This unregulated supply voltage powers the quad op amp (IC6) and the quad comparator (IC7). Regulator REG1 provides a 5V supply for the infrared receiver (IRD1), the LEDs and the pulse stretching circuit of the clip detector.

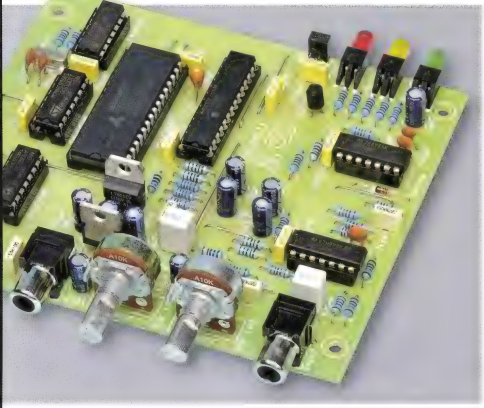
The 100µF capacitor at REG1's output reduces noise on the 5V line and the 10Ω series resistor reduces regulator dissipation by about 100mW. The load on the 5V regulator draws around 100mA and depending on the supply voltage it drops between 2.3V and 5.3V, giving a dissipation of 230-530mW. It does not need a heatsink although if the supply voltage is at the upper end of the range it will run hot to the touch.

The 5V supply for IRD1 is further filtered with a 100Ω resistor and 100nF capacitor to keep switching noise from the other components away from IRD1, as infrared receivers can be quite sensitive to power supply noise.

The majority of current drawn from REG1 is actually for the +3.3V rail which is regulated by REG2 for the microcontroller (IC1), SRAM (IC2) and the digital logic ICs (IC3-IC5). The 100µF capacitor at its output is not just for filtering; it is required for stability since REG2 is a low-dropout type.

Construction

Before assembling the PCB, check the copper side for any defects such as broken tracks or under-etched areas



and repair if necessary. Also check that the board fits inside the case when the plastic end-panels are in place and that the mounting holes line up with the plastic posts. It's a good idea to then test-fit the larger components, such as the RCA sockets, to ensure that the holes have been drilled large enough.

Refer now to Fig.4 for the assembly details. Start by installing the 14 wire links using tinned copper wire. Alternatively, 0Ω resistors can be used in some locations if desired. Make sure that the links are straight, so that they can't contact adjacent pins later.

You can straighten the link wire by clamping one end in a vice and pulling on the other end using a pair of pliers, to stretch it slightly.

Follow with all the fixed value resistors, using a DMM to check the value of each one before soldering it in place. The two diodes can then go in, taking care with their orientation (they face in opposite directions). The larger 1N4004 resistor goes at the top of the board, near the power socket mounting location.

The IC sockets and any ICs that are being soldered directly to the board can go in next. In both cases, ensure that the notch or pin 1 marker is lined up as shown on the overlay diagram. If you don't have a 32-pin socket for IC2, you can cut four pin rows off the end of a 40 pin socket using side-cutters, or you can use pin header strips.

Now install the three 5mm LEDs, using plastic right-angle LED mounting blocks. In each case, start by inserting the LED's leads through the holes in its mounting block, with the anode (longer lead) aligned so it will go through the pad nearest the anode (A) marking on the overlay. That done, bend the leads down to a right-angle, using the mounting block as a bending jig. The assembly can then be soldered in place.

If you don't have plastic LED mounting blocks, you can instead bend the LED leads 5mm from the body and install them with the horizontal portion of the leads 3.5mm above the top of the PCB.

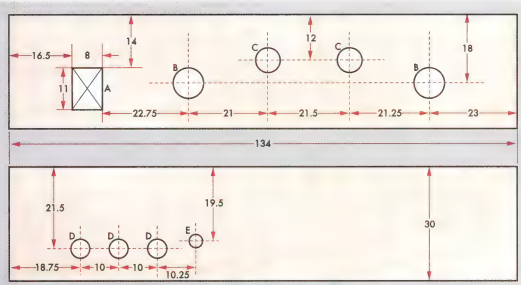
Now fit the ceramic and MKT capacitors. Don't get the different values mixed up. Transistor Q1 (BC557) can then be soldered in place. If necessary, crank its leads out using small pliers before fitting it to the board.

Next, bend the leads of the infrared receiver back away from the lens at right angles, as close to the body as possible. That done, bend them back down again, leaving a 4mm horizontal lead section. The IR receiver can then be pushed all the way down onto the board and soldered it in place – see photos.

Follow with the tantalum capacitor. This device is polarised, so make sure it goes in the right way around. Its positive lead is indicated by a "+" symbol on the body and is usually on the right with the label side facing you. The electrolytic capacitors can then

Table 3: Resistor Colour Codes

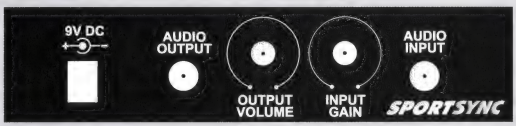
❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	1MΩ	brown black green brown	brown black black yellow brown
❑	5	100kΩ	brown black yellow brown	brown black black orange brown
❑	2	22kΩ	red red orange brown	red red black red brown
❑	2	13kΩ	brown orange orange brown	brown orange black red brown
❑	3	11kΩ	brown brown orange brown	brown brown black red brown
❑	6	10kΩ	brown black orange brown	brown black black red brown
❑	4	2.2kΩ	red red red brown	red red black brown brown
❑	5	1kΩ	brown black red brown	brown black black brown brown
❑	3	300Ω	orange black brown brown	orange black black black brown
❑	3	100Ω	brown black brown brown	brown black black black brown
❑	2	10Ω	brown black black brown	brown black black gold brown



HOLE A: 8 x 11mm RECTANGULAR HOLES B: 8mm DIAM. HOLES C: 6.5mm DIAM. HOLES D: 5.0mm DIAM. HOLE E: 3.5mm DIAM.
ALL DIMENSIONS IN MILLIMETRES

Fig.5: use this drilling template as a guide for making the holes and cut-outs in the two plastic end-panels for the case. It's best to use a small pilot drill (eg, 2mm) to start the holes (so that they are correctly centred), then carefully enlarge them to size using large drill bits or a tapered reamer.

Fig.6: the front and rear panel labels can be copied and attached to the end-panels. Alternatively, a PDF of these labels can be downloaded from the SILICON CHIP website and printed out.



all go in, again taking care to ensure they are orientated correctly. Don't get the different values or voltage ratings mixed up.

Next, fit the RCA sockets and DC connector. In each case, the connector must be pushed down right onto the PCB and adjusted so that it is at right angles to the board edge before being soldered in place. The crystal (X1) can then go in, followed by regulators REG1 & REG2.

Note that the metal tabs of the regulators face away from each other. Ensure that the 3.3V regulator is installed nearest to the PCB edge.

Now for the two potentiometers (VR1 & VR2). Before mounting them, cut the shaft of each pot to a length of 17mm using a hacksaw and file off any burrs. The two pots can then be soldered to the board, making sure they are pressed down fully and that their shafts are parallel with the PCB surface.

Finally, complete the PCB assembly by inserting the ICs into their sockets. Check that they are all correctly orientated; if not, they could be damaged when power is applied.

Testing

It's a good idea to carry out a few tests before installing the board in a case. To do this, first place the completed PCB on a non-conducting surface and turn both potentiometers fully anti-clockwise. That done, connect a power supply with a DMM (set to measure amps) in series with one of the supply leads.

Now apply power and watch the LEDs. Initially, all three LEDs should come on but the red LED should turn off after a second or so. Check that the current is around 100-120mA.

The green and yellow LEDs should remain on during the initial memory test, which takes 2-3 seconds. At the end of this period, the state of these LEDs indicates whether or not the board is functioning normally:

- Green LED only: memory test successful, operation is normal.

The board fits neatly inside a standard plastic instrument case from Jaycar or Altronics.

- Yellow LED only: memory test failed – check that IC2 is properly installed and that there are no solder bridges, short circuits or broken tracks.
- Both LEDs off or remain lit for more than a few seconds – microcontroller or power supply failure.
- Red LED remains lit for more than a few seconds – error in analog input circuitry – check that IC6 & IC7 and their associated components are installed correctly.

If, after a few seconds, the green LED is the only LED lit and the current drain is around 100mA, you can proceed with an audio test. You will need to connect a signal source (eg, an AM radio) to the input connector and headphones or an audio amplifier to the output connector.

Having done that, turn up the gain knob until the red clip LED lights, then turn it down slightly so that it is no longer does. Now turn up the volume control – you should hear the signal source being repeated at the output with a slight delay (around 0.2s). If you can hear it clearly, then the unit is operating normally.

Now check that the remote control works. Set it to the appropriate Philips VCR code (eg, 115 for the Altronics A1012 remote and 916 for the Jaycar AR1726), point it at the receiver and press the 1, 2 & 3 number buttons. The yellow LED should flash in response and the audio delay should change to be 1, 2 or 3 seconds depending on which button is pressed. Check also that the volume down/up buttons work.

Finishing construction

Fig.5 shows the drilling details for the end-panels of the plastic case. Start with 2mm pilot holes on the rear panel, then enlarge them using a tapered reamer or larger drill bits. Check the hole sizes regularly by test fitting the panel to the pot shafts and the RCA connectors. When the hole sizes are correct, de-burr them using a larger drill bit.

For the DC socket, start with a 5mm hole in the centre and then enlarge the hole to a rectangle using a needle file. Continue until the DC connector fits neatly through the hole.

The front panel requires three 5mm holes to accept the LEDs plus a 3.5mm hole for the IR receiver. Again, it's best to start these holes using a small pilot drill (eg, 2mm), to ensure accuracy.

The bottom of the case has eight moulded plastic posts. The four inner posts must be removed (or reduced in height), otherwise they will interfere with the solder joints on the bottom of the PCB. Use sidecutters to make vertical cuts in the side of each post and then small pliers to break sections off. They can then be filed to a neat finish.

Once the drilling is complete, attach the rear panel to the PCB using the potentiometer washers and nuts. That done, push the front panel into place and then slide the whole assembly into the case. Check that the PCB sits correctly on its mounting posts and that the lid can be fitted with everything in place.

It's then just a matter of laminating the front and rear panel labels before attaching them using spray adhesive. These panels can be downloaded from the SILICON CHIP website (in PDF format) and printed out, or you can use a copy of Fig.6. You will have to temporarily remove the assembly from the case and detach the panel in order to fit the labels.

Alternatively, if you purchase a kit, the labels will either be supplied or the panels will come pre-drilled with screened lettering.

Once the labels are on, cut out the holes using a sharp hobby knife, then refit them to the PCB. The assembly can then be lowered into the case and secured using four self-tapping screws. Complete the assembly by fitting the lid and pushing the two knobs onto the potentiometer shafts.

Using it

Using the device is easy. First, connect the output of your radio to CON2 (Audio Input). Most small radios have a 3.5mm stereo jack headphone output so you will need to use a 3.5mm stereo jack to twin RCA plug cable. Plug the jack into the radio and connect one of the RCA plugs to CON2.

Sport commentary is typically on AM radio which is usually monaural so it may seem redundant to use a stereo cable. However, since most

The front panel carries the three indicator LEDs plus an adjacent hole for the infrared receiver. The two pots (Input Gain and Output Volume) are mounted on the rear panel and once set for a particular installation, should not need touching again. Also on the rear panel are the input and output RCA connectors and a DC power socket.

Virtually any universal IR remote control can be used to operate the SportSync Audio Delay, including this Digitech unit from Jaycar (Cat. AR1726). The Altronics A1012 is also suitable (see text for codes).

radios can also receive stereo FM, we don't want to insert a mono plug and risk shorting the two output channels together. It probably won't cause any damage but it's best not to find out.

Some radios have RCA output sockets and in this case a cable with an RCA plug on each end is all that's required.

The unit's output can be connected to headphones, earphones, a power amplifier or a TV's audio input. Headphones or earphones may be connected directly, using an RCA to phono jack cable, or via a headphone amplifier. Most power amplifier and TV audio inputs will be RCA sockets so a simple RCA plug to RCA plug cable should do the trick.

With the connections made, follow this step-by-step procedure to adjust the unit and set the levels:

(1) Set the Input Gain control to about two-thirds clockwise, then turn the radio's volume control up until the Clipping LED just lights. If necessary, advance the Input Gain control further to achieve this. When the Clipping LED comes on, turn the radio's volume down until it goes out again.

(2) Turn the Output Volume down and apply power. Wait until the green LED lights, then advance the Output Volume until you hear the radio.

(3) Set the volume to the loudest level that you would ever use, then use the remote control to turn the it down to a comfortable level. This will give you an appropriate volume control adjustment range.

(4) Set the delay to synchronise the audio to the TV image. You will probably need to wait for a sport event in order to set it.

Initially, use the number buttons on the remote control (0-9) to set the delay, in seconds. If eight seconds is not enough then press the number nine and the sampling rate will automatically drop. This is indicated by the flashing green LED.

With a sampling rate below 39kHz, the 0-9 buttons no longer correspond exactly to a number of seconds but instead set the delay somewhere between minimum (0 button) and maximum (9 button).

(5) To increase the delay beyond 9 seconds or to make fine delay adjustments, use the channel up/channel down buttons. You will need to use these buttons to get the delay just right.

Once the delay is correct, it will be remembered next time the unit is switched on, along with the volume setting. You can also use the Mute button on the remote to temporarily switch the sound off. When the unit is muted, the yellow LED will flash periodically. SC

DAB+ Digital Radio

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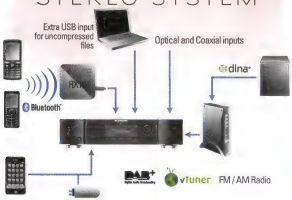

The NA7004 is armed with an extensive list of cutting-edge features including Network Streaming, Internet Radio, a high-end Tuner with DAB+ Digital Radio (as well as AM/FM), a USB input with high-quality D/A conversion, iPhone/iPod direct access … all reflecting the same 57-year musical heritage as a Marantz's award-winning stable of CD players.

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For more information and stockist demonstration centres, please visit: **www.qualifi.com.au/product/NA7004**

PRODUCT SHOWCASE

New Marantz network audio player with DAB+ & FM/AM tuner

The new Marantz NA7004 network audio player has an extensive list of cutting-edge features including USB D/A converter mode for superb sounding PC connection, iPhone/iPod Digital Direct ability, as well as network streaming, Internet radio and a built-in, high-end tuner for both DAB+ and FM/AM.

The NA7004 is the perfect addition to any existing stereo or home theatre system, opening up streaming media. Today's music libraries are increasingly stored on home computers and the Marantz NA7004 is fully equipped to get the best from your hard disk drive-stored tunes. With the same musical philosophy as Marantz's award-winning stable of CD players, it utilises the CS4398 stereo DAC also found in the $2,500 SA-KI Pearl Lite player.

Additional features include Marantz's HDAMSA2 circuitry, as well as the maker's

latest version of its compressed file sound-improving MDAX2 technology.

The USB D/A converter mode is perfect for PC-stored music, while the front USB enables Digital Direct replay from iPods and iPhones, as well as USB storage units. The NA7004's DAC is also accessible via the rear panel's optical/coaxial sockets for signals up to 24-bit/192kHz, while Internet Radio vTuner sounds superb via the Marantz machine's ethernet network connection.

For extra convenience the NA7004 is DLNA version 1.5 certified DMP (Digital Media Player) and DMR (Digital Media Rendered).

The NA7004 is available now in a black finish with a suggested RRP of $1,499.

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124 Lionel Rd, Mt. Waverley, Vic 3149
Tel: (03) 8542 1111 **Fax:** (03) 9543 3677
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New Battery Book from Siomar

If you're looking for a battery – any battery – to fit anything, the chances are you'll find it in The Battery Book.

The newest edition, No 6, is updated and contains just about every variation of batteries you've ever thought of – and probably a huge number you've never thought of!

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Tel: (08) 9302 5444 **Fax:** (08) 9302 5470
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PICAXE shield PCB

MicroZed Computers, Australian distributors of PICAXE products, have available a PICAXE shield development board.

The PICAXE shield base is an open-source hardware 'Arduino inspired' controller board, designed to enable PICAXE use of the multiple different 'shields' that are now available.

The shield base has been very carefully designed to be compatible with the vast majority of existing shields. Each PICAXE shield base is also provided with a free of charge AXE405 prototyping shield PCB for experimentation. The PCB designs are released as 'open-source' and 'not for profit' designs.

The firmware is based on the PICAXE-28X2 chip. Full details are available from www.picaxe.com.au

The PICAXE shield is supplied as a blank PCB plus a prototyping shield PCB for those who want to build their own and retails for $4.95

Contact:
Microzed
Unit 5, 10 Kabi Cct, Deception Bay Qld 4508
Tel: 1300 735 420 **Fax:** 1300 735 421
Website: www.microzed.com.au

Fluke's 2AC VoltAlert is always on

The Fluke 2AC VoltAlert AC non-contact voltage tester detects energised circuits and defective grounds, making it an ideal first-line go/no-go tester for an electrician, on the factory floor or for do-it-yourselfers around the house. The tip of the pocket-sized tester will glow red in close proximity of an outlet, terminal strip or power cord where voltage is present, detecting voltages from 90 to 1000V.

With the pocket-sized Fluke 2AC VoltAlert, users have a quick and convenient tool to quickly check circuits and equipment to see if live voltage is present.

The Fluke 2AC includes a new always-on feature, allowing it to be ready to use at a moment's notice. The tester has special low power circuitry to sustain battery life plus a battery check function. It is powered by two AAA cells.

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Fluke Australia Pty Ltd
Unit 26, 7 Anella Ave, Castle Hill, 2154
Tel: (02) 8850 3333 **Fax:** (02) 8850-3300
Website: www.fluke.com.au

Av-Comm's $29.95 wind-up/solar powered AM/FM/SW radio has a torch, siren, flasher, mobile phone charger . . .

If you ever get yourself into a sticky situation, here's one thing you don't want to be without!

The Degen DE13 Emergency Radio from Av-Comm not only receives AM, FM and two bands of shortwave radio broadcasts, it will do it long after the batteries have gone flat – thanks to (a) the solar panel charger mounted on top and (b) the hand crank on the back. Wind a few turns and you have several minutes of radio. Wind longer, you get longer.

But, as the man says, there's more. This incredible radio also has a built-in LED torch and a red LED flasher, along with a siren to attract attention.

But wait, there's even more: it also has a USB socket built in which will charge most modern mobile (cell) phones and yes, it will do that as you wind the crank. That's handy!

It also takes standard AA batteries if you don't feel like winding or letting it stand in the sun! When not in use, the crank folds into a recess on the back.

This amazingly handy and versatile radio (+!) is available (while stocks last) from Av-Comm for just $29.95 ***including*** p&p.

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Av-Comm
PO Box 225, Brookvale NSW 2100
Tel: (02) 9939 4377
Website: www.avcomm.com.au

Zigbee wireless sensor

Ocean Controls has a series of Zigbee Wireless modules which can be easily used in applications such as Industry and Building Automation where wide area monitoring or control is required.

The IEEE 802.15.4 modules operate in the 2.4GHz license-free band and have a range of 120m (line of sight), which can easily be extended by the use of routers. They can be quickly configured into a Tree type structure with a PC connected to a central coordinator and routers allowing the I/O modules to be distributed around a factory or compound. The coordinator can communicate in Modbus RTU or TCP/IP allowing most SCADA software to control and monitor the modules. Ocean Control's software ISEE-Modbus TCP can be easily interfaced to the modules.

The I/O modules feature a temperature/humidity unit, analog input/output units and digital input/output units.

With prices starting at $149+GST for the Wireless I/O modules and ISEE-ModbusTCP software this can make a very cost effective solution for monitoring and control.

Contact:
Ocean Controls
PO Box 2191, Seaford BC, VIC 3198
Tel: (03) 9782 5882
Website: www.oceancontrols.com.au

iPhone/iPad/iPod Touch app: Number Base Convertor

Cute Apps has made it easy to view Decimal, Hexadecimal and Binary number equivalents all at the same time!

10 0A 1010 [Ten] is an app that has been thoughtfully designed by programmers for programmers, with a calculator-style interface that makes this utility simple to use.

Ten will automatically change the Integer Format type between an 8-bit signed/unsigned, 16-bit signed/unsigned and 32-bit signed/unsigned.

When dealing with 32-bit floating point numbers, Ten allows the user to change between the PIC Microchip Format and the IEEE-754 Format. This allows for quick verification of a variables' memory contents as well as being an invaluable tool when debugging 32 bit conversion code. Decimal numbers are displayed to 9 significant digits. All Hexadecimal numbers requiring more than one byte are displayed in Big-Endian format ie, MSB to the left, LSB to the right.

Cute Apps is offering a free promotional code to the first ten people who make contact via support@cute-apps.com

Ten is available from the app store for US$1.99 SC

Contact:
Cute Apps
Website: www.cute-apps.com

Eco backpack with built-in solar charger

This cool new ECO BAG backpack from the Solar Energy Store features a solar panel on the outside which soaks up energy when the bag is in sunlight.

The solar energy charges a battery included with the bag and the adapters included transfer the power to your favorite electronics, such as your camera, iPod, iPhone etc !

It's ideal for the bushwalker, jogger, student, office worker . . . in fact just about anyone who would use a conventional backpack. And the price is only $39 – not much more than you'd expect to pay for that old-style backpack.

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The Solar Energy Store
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Website: www.solarenergystore.com.au

Jaycar Electronics 30 YEARS OLD – AND BOOMING!

While Jaycar is now the dominant electronic parts retailer in Australia it had very small beginnings, 30 years ago. Since then it has grown from a single run-down store in a virtual dungeon in a Sydney lane to an operation with 72 stores (and climbing) and employing over 1100 people in Australia, New Zealand and elsewhere. Leo Simpson recently sat down with the owner, Gary Johnston, to chew the fat and review some of the high points.

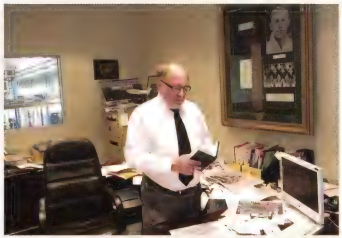
Just over 30 years ago, Dick Smith Electronics was blazing the way and showing how kits and electronic parts should be retailed. Gary Johnston, one of the key men in Dick Smith's management team was doing very nicely.

Then in around 1980 it all changed, with Dick deciding to sell to Woolworths for a very good price. At that stage though, Dick Smith Electronics had only 18 stores and about 34 country dealers. It has grown enormously since then, of course, to the giant we know today.

But that sale left Gary Johnston feeling that he should move on. In early 1981 Dick Smith put a newspaper clipping from the "Businesses for Sale" section of the Sydney Morning Herald on Gary Johnston's desk, concerning a tinpot electronics shop in Sydney's Sussex Street – John Carr & Co – with a view to possibly acquiring its stock and maybe the whole business.

Subsequently, it was thoroughly assessed by Gary Johnston and DSE's General Manager, Ike Bain. Both concluded that the business was positively Dickensian – and not a proposition for Dick Smith Electronics because it would require too much hassle and work to make it worthwhile. There was an enormous inventory of quite obscure stock which hadn't moved in years and was unlikely to ever do so. (What do you do with several thousand radio tuner dial drums?)

Not the first Jaycar store (they didn't even have a camera!) but the second, in York St, Sydney in 1982 – together with the entire Jaycar company "fleet".



Gary Johnston in his office at Rydalmere. His desk isn't always this cluttered – he claims he cleaned it up especially for our visit . . .

So Gary Johnston decided to make the jump from his very safe and well-paid position at DSE and go out on his own. And what a huge jump it turned out to be.

He bought John Carr & Co (including all that stock) and changed the name to a much more "marketable" Jaycar. As Gary himself admits, he had no idea or expectation that the business would grow to the size that it is today. He was just going to give it a go!

Gary's initial strategy was to do as much as he could to not directly compete with Dick Smith Electronics – he did not want to be crushed by them! To do so, he concentrated on some of the bigger and more complex kits and he was helped in that regard because he inherited some projects from John Carr & Co, such as the ETI 4600 synthesiser (which was such a poor seller due to the amount of parts needed, that he liquidated the stock).

Compare the catalogs! Jaycar's first effort from 1981 (great for the time!) with this year's 508-page behemoth. You should find a free copy with this issue of SILICON CHIP – if not, someone's beaten you to it!

But about the same time, ETI produced the very popular ETI 5000 amplifier by David Tillbrook. Jaycar promoted it heavily with a "blue-printed" version. They were pretty adept at marketing – and they still are. Gary freely admits he learned a lot from a certain "guru" at DSE!

The mention of the Jaycar name should also be explained. John Carr & Co had already registered the name Jaycar many years previously but it did not begin trading under that name until March 2nd, 1981, under Gary's stewardship. Jaycar then was launched to the world, with plenty of advertising in *Electronics Australia* magazine. Jaycar also got involved with ambitious projects of its own, such as the electronic piano featured in the same magazine.

Gary brought enormous energy to the business and only a year later he moved to York Street, Sydney, and in the process acquired Electronics Agencies, who also had premises at Concord, in Sydney.

This gave Jaycar the agency for the popular Microbee computer (produced by Owen Hill's Applied Technology), a few key staff such as Bruce Routley, and the ability to produce an annual catalog.

By 1984 Jaycar had five stores and about 20 employees. In 1987, Jaycar opened their first Melbourne store, in A'Beckett Street. Needless to say, it went like a rocket. Shortly after, they opened in Springvale. So they kept opening stores – and growing like wildfire. By the mid-1990s, they had 12 stores and a large warehouse at Leeds Street, in Rhodes (Sydney).

By that time Jaycar was also becoming a recognised brandname for electronic componentry and all the stuff used by technicians and enthusiasts. More regional and country stores were buying from the wholesale division, Jaycar Wholesale.

Gary wanted a new name for the wholesale operation and something that would not be seen to have a particular meaning. It used to irk him that some people thought that Jaycar was a car parts business!

This was during a federal election and his gardener came up with the name "ElectMe". Gary thought that was good but then he changed it to "Elect Us" and that's how the name Electus Distribution came into being. And you thought it had something to do with electronics or electrical – didn't you? At the same time, a general manager was appointed to oversee the whole business and the target was to grow it into a $100 million company (sales per annum) within the next few years. Suffice to say, that target was exceeded quite some time ago. To go back to the car analogy, Jaycar has been accelerating ever since!

Painfully aware of the fact that they had massively outgrown their Rhodes warehouse, Gary searched for suitable premises. Dick Smith even suggested that Gary might consider the nowempty former DSE headquarters at North Ryde. But Gary had to say "sorry, Dick, it doesn't work. It's much too small!".

The Jaycar/Electus operation moved to a very much larger complex in Silverwater . . . where it lasted only a few years before once again, they were out of space. They then bought the current head office and warehouse complex at Rydalmere. Again dramatically larger than Silverwater, they've only been there a couple of years – but already, Gary is eyeing off nearby properties to cope with yet more expansion.

Along the way, they acquired Soanar Electronics, a large supplier of semiconductors and other OEM components from the Dutch multinational, Hagemeyer NV. Since then, that business has also grown considerably and also has offices in several countries in Asia.

Together with all the growth, Jaycar and Electus Distribution have become very professional in their entire operation, with every aspect of the business having defined procedures. McDonalds is known for their professional operation – Jaycar is run along similar lines.

Gary Johnston and Jaycar have also developed strong ties with the University of New South Wales and in particular with their solar panel research. In 2006, he donated $1 million to create Australia's first chair of Water Management, headed by Professor Ian Acworth. This is in line with Gary's desire to see a much greater understanding of Australia's entire water resources, including its river and aquifers.

And the future?

The Jaycar group will continue to grow and new management appointments have recently been made, including the promotion of long-time marketing manager Toni Martin (a qualified engineer) to the position of CEO.

At present, Jaycar have some 72 stores and over 1100 employees spread throughout Australia and New Zealand and offices in Asia.

A big challenge is to grow all aspects of the business, including online operations in Europe, USA and in fact, the world. Who knows how big it might be in another 30 years' time! SC

About those "rumours" . . .

Every so often, we hear (or see) claims to the effect that Jaycar Electronics owns SILICON CHIP, or vice versa (we wish!) – or that one has a financial interest in the other.

It's often repeated on internet newsgroups or other Pope-like sources of infallible information. "A friend of my cousin's aunty works for Jaycar and he told me that . . ." or "I know for a fact that Gary Johnston helped Leo Simpson start SILICON CHIP and that's why they always have the centre of the magazine for their advertising . . ." Or somesuch other claim (we've heard them all!).

Let's state here and categorically:

SILICON CHIP and Jaycar Electronics have NO financial interest of any description in each other. And never have had!

Sure, the companies ocasionally work together to develop projects and Jaycar is our largest advertiser. But that is it!

SERVICEMAN'S LOG

The second Christchurch earthquake

From first-hand experience, I can tell you that being caught in a major earthquake is a terrifying experience. The damage here in Christchurch is extensive and although my house survived, it's had a devastating effect on my business.

Items Covered This Month

- The Christchurch earthquake
- Tech tales – all true
- Old monitor repair
- An obsolete TV repair (NEC CP785F chassis)

A scientist, when asked about the aftershocks following last year's big quake here in Christchurch, declared the city the "safest place on earth". His reasoning was that it was highly unlikely we would suffer another large seismic event in the near future.

He was very wrong. At 12:51pm on February 22nd 2011, when the city centre was overflowing with lunchtime crowds, a shallow quake shattered the normality. Within 20 seconds, it had stolen the lives of some 200 people and left much of a beautiful city in ruins.

Our family and wider circle of friends all survived but our house was left in a mess. Many of our possessions were tossed about and broken beyond belief but they are material goods that can either be replaced or done without. On a personal note, I would like to thank those people, including many total strangers from Australia, who sent messages of support. They really do make a difference.

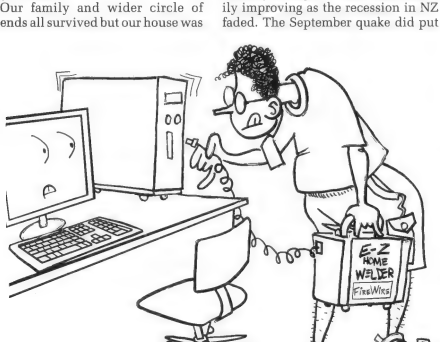
The main casualty for us is our computer repair business. Since the global recession, which disproportionately affected many small businesses like ours, trade has been slow. Until recently though, it had been steadily improving as the recession in NZ faded. The September quake did put the brakes on again but after a few months, the general feeling was that we were over the worst of it – or in one friend's words, people were putting "the good china back up".

Our own business was healthier than it had been for more than two years; so much so that I was considering taking on another technician to assist my sole remaining staff member (down from a high of four two years ago). However, at 12.51 on that Tuesday, my 15-year-old business came to a sudden, crashing halt.

I was lunching with my wife across town at the time. When the quake struck, we somehow escaped from the shopping mall we were in and headed straight home. The further east we travelled, the bleaker things looked, with the streets increasingly showing signs of liquefaction and more and more brick fences and homes in ruins.

Frustratingly, most phone systems crashed due to overloading, though miraculously the "minnow" network we use (2degrees) was still working for SMS between 2degrees customers. However, I couldn't call or message landlines or mobiles on other networks but we could reach key friends and family as well as my technician at the workshop.

After finding that our house and cats were relatively OK, I made my way through the increasingly makeshift cordons towards the workshop, skirting the most badly damaged roads where I had to. Even so, many roads were almost impassable for my small work van. As I slowly passed the collapsed buildings, I saw people being pulled from the wreckage and the huge



MOST PEOPLE ALREADY KNOW NOT TO RANDOMLY PLUG IN HARDWARE WITH A MACHINE RUNNING...

piles of rubble and grimly feared the worst. It looked very bad indeed.

After the September quake, which measured 7.1 and was located about 40km away (and about the same depth underground), the extent of the damage at my workshop was just a few tools on the floor. We opened the next day and while business was patently slow, it picked up nicely as time passed. We saw a cluster of quake-related problems, mainly damaged hardware due to power surges, as well as the odd broken laptop or desktop due to a machine falling or having something fall on it.

By contrast, this latest quake measured a "paltry" 6.3 but was centred only 6km from my workshop. It was also far shallower that the previous quake, being about 6km below ground, and its effects were far more devastating.

The first thing I noticed on arrival at my workshop was the almost knee-deep liquefaction that covered the small forecourt in front of the building. This fetid, stinking, clinging mess was black, dense and still oozing water at an alarming rate, adding to the already flooded and torn-up roads. My technician was white with shock and stress; he couldn't enter the workshop as the door had jammed shut after he had left the building.

I jemmied the door to get in and immediately wished I'd stayed outside. Every monitor, computer and peripheral was either up-ended on the centre work benches or was on the floor, half-buried in sand and water. What amazed me was that there was as much liquefaction inside as there was outside. The only difference was that the walls trapped the water inside and so it was getting deeper by the minute, instead of draining away as it did outside.

My heart sank as I moved through the various rooms and offices, picking up our server from the mud as I went. I quietly hoped that at least one of the hard disks from the array would still be operational and this later proved to be the case. Our main backup drive had also been tossed from its "secure" cupboard and was sitting in silted water. I forlornly hoped that it would still work but as I later found out, it didn't.

I also discovered that the overhead fluorescent lights had swayed so much that they had either hit each other or the roof. As a result, they had shattered and their fine glass and toxic powder had been added to the mess below.

In the end, I turned off the power and water, grabbed what I could and left. It was obvious that there would be no work done in this workshop for quite some time, if ever. Even if the engineers were generous and awarded our building a green sticker, who would come when the roads were all but impassable?

If past experience is anything to go by, the first three or four months will see very little business. People will be more worried about putting food on the table and living in a house with a roof that connects to the walls than getting the family computer fixed.

I understand those priorities because we are all living in the same "blitz" conditions, initially queuing for rationed bread, milk and petrol and – in many cases – water. In short, all the simple things that we take so much for granted until they are no longer readily available.

As I write this, many people are still sharing portable toilets with four other families because the sewerage system is not operational. And parents have to look after the kids during the day because the schools are shut until further notice – which is fine because Mum and Dad don't have to go to work because work (in many cases) doesn't exist any more.

Many jobs will be gone for good and that's heartbreaking for those who are now unemployed. In short, people aren't thinking about RAM upgrades or virus removal or essential Windows updates and I can't fault them one little bit for that. Because you know what? For the present, neither am I!

I'm sure that life will get back to normal eventually but in the meantime, here are some stories from my workbench, before the big quake hit.

Tech tales – all true

I tend to see a lot of quite outrageous things in my line of work, many done by people who really should know better. For example, I could tell you about the client who thought every plug inside his computer should be

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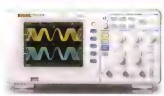

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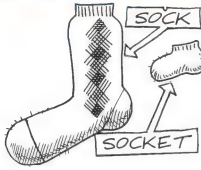

As for the fault, after discharging the offending capacitor (a healthy crack indicating that a significant charge was still left in it), I cautiously continued trying to track down the fault. All roads seemed to point to an unmarked 14-pin IC which I assumed to be the heart of the control circuit. Unfortunately though, I had no circuit diagrams and a search on the web didn't turn up anything, so it was all just guesswork.

At that stage, I hunted through some old monitor chassis we had stacked up in the back room and found one of the same brand and similar age. It had a similar unmarked chip sitting near the front panel loom plug, though the chances of it being identical were highly unlikely. Still, I had time on the clock and nothing to lose so I removed it and substituted it for the suspect chip on my client's board.

I reassembled the monitor, plugged it in, crossed my fingers and switched it on. Lo and behold – it didn't work. Well, it did work, sort of – just the same as it did before, so that IC obviously wasn't the fault. Oh well, it was worth a shot.

At that point, I advised the client of my findings and he decided to accept my original advice to buy a new monitor from us. The last time we spoke, he was over the moon with it and had realised that he should have replaced the old one ages ago!

Obsolete TV repair

This next item is from a regular contributor, D.S. of Maryborough, Qld. Here's how he tells it . . .

An NEC flat-screen CRT television came in with the story that it had "just stopped working". Hmmm, that's what they all say!

This particular set used the CP 785F chassis and most of the functions are covered by a microcontroller, with the settings stored in an EEPROM. It took me next to no time to confirm the startling fact that the TV didn't work.

Closer inspection revealed that the main supply fuse was open circuit, so I checked for shorts on all the supply rails but found none. I then checked the switching transistors and their isolation tabs but still nothing.

It was the same story when I removed all the electrolytics from the power supply. They were all OK, so I moved onto the degaussing coil but it too was OK. So where to from here?

At this point, I decided to chance my arm by replacing the fuse and powering the unit up. Well, it stayed on but there were a couple of serious issues – the bottom of the screen had serious distortion in both corners and the on-screen display was unreadable. It looked very much like a degaussing issue to me.

As I reached for the power switch, there was a small hissing sound accompanied by a burning smell but the picture remained as it was. I then switched the set off and removed the PC board for a closer look.

That's when I discovered a missing track between the degaussing coil connector and the Posistor. I removed the Posistor and it literally fell apart in my hand. From there, it didn't take a genius to figure out why screen distortion was present.

Unfortunately, I was unable to read the details off the posistor so I had to dig out a service manual. This has a full component list and it showed that the Posistor is a 7-ohm DPC7R0M290 unit which, of course, I didn't have. A quick call to my spare parts supplier soon fixed that.

In due course, I replaced the Posistor, bridged the missing track and gingerly switched on. Well, the screen distortion had been laid to rest but something was still was amiss. The on-screen display was still unreadable and I was unable to adjust the picture parameters.

Clutching at straws, I then used the circuit diagram to trace several data lines. I then removed the relevant parts from the PC board and tested them but they all passed with flying colours. It was then that I noticed a small sooty mark around I820, a 7805 5V regulator. If this regulator had failed (and as reliable as they are, they do fail), there would be no 5V supply rail to several areas of the circuit, especially to the micro, the I²C lines, the serial EEPROM and many other vital sections.

A quick check with my DMM confirmed that there was no output from this regulator so I replaced it. This time, the set gave a perfect picture and quite decent sound with no adjustments required, so I left well enough alone. The set ran for three days with no further issues and it was duly returned to its owner.

As an aside, I rarely get to fix CRT TVs these days, with people now dumping perfectly working (but now obsolete) sets. In fact, a friend of mine has a 68cm Sony TV in as-new condition which he plans to drop off at his local council's e-waste collection depot next weekend.

Finally, to all those "in the know" out there in electronics land, I have a question. I have never understood the full operation of the Posistor, even though I have replaced a great many. Can someone enlighten me?

Editorial note: *a Posistor is a resistor with a large positive temperature coefficient, so that the hotter it gets, the higher its resistance becomes. Posistor is a registered trademark of Murata Manufacturing Co Ltd of Japan but these devices are also known as PTC thermistors.*

In the case of the Posistor in series with the CRT degaussing coil, its initial low resistance allows a high current to flow in the coil and the resulting high AC magnetic field demagnetises any residual magnetism that adjacent steel metalwork around the CRT may have acquired. The degaussing coil and the Posistor are connected in series across the full mains voltage (230VAC) and the initial surge current is typically around 5A.

After about a second, the rapidly increasing resistance of the Posistor effectively cuts off the current through the degaussing coil which would otherwise burn out.

CRT monitors also used degaussing coils but instead of using a Posistor to degauss every time the monitor was switched on, the degaussing coil was only operated by a concealed pushbutton when the picture showed obvious colour purity problems. SC

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MAY 2011

250 Lumen CREE® LED Torch

NEW 2011

High powered 250 lumen CREE® LED torch with a fully adjustable beam spread. Twist the grip at the head of the torch clockwise to focus the beam on an object up to 200m away or anti-clockwise for a wide beam to light up your immediate vicinity.

- Requires 3 x D Batteries (not included)
- Burn time: 3 hours
- Dimensions: 250(L) x 54(Dia)mm

ST-3455

$49.95

Also available: 260 Lumen Rechargeable CREE® LED Torch ST-3453 $69.95

2600 LUMEN 24W HID TORCH

Here's a compact and very bright rechargeable torch at an affordable price. Comes in machined aircraft grade aluminium and finished in anodised black. Includes an aluminium case, mains and cigarette lighter chargers. An IPX3 water resistance rating makes it suitable for camping and outdoor activities.

- Output: 2600 lumens
- Burn time: 100/140 mins
- Light modes: High/Low
- Water resistant: IPX3
- Built-in rechargeable battery: 6600mAh
- Dimensions: 235(L) x 70(Dia)mm

ST-3361

$199.00

NEW 2011

LED FLASHLIGHT WITH HD VIDEO CAMERA

Compact HD video camera with built-in LED flashlight. Video can be recorded at 720P and the LEDs enable night time and low-light recording. Its compact size and features make it a handy tool for security and surveillance applications. It also takes photos, accepts a MicroSD (up to 32GB) card and can be used as a USB storage device.

- Recording format: AVI
- Recording time: up to 4 hours
- Video compression: MJPEG
- Built-in lithium rechargeable battery
- Dimensions: 111(L) x 32(Dia)mm

QC-8010

$129.00

NEW 2011

DEAL OF THE MONTH!

2.4GHz Helicopter with 4 Channel Control

Super light and extremely rigid aluminium frame helicopter has four channels allowing you to control the elevation, forward, back, bank left/right and left/right rotation. It has a built-in gyroscope for stable flight, 2.4GHz remote control. 20 minutes charge gives about 10 minutes flight time. Spare parts available separately.

- Chopper battery: 7.4V Li-Po 850mAh
- Frequency: 2.4GHz
- Remote unit requires 8 x AA batteries
- Suitable for ages 10+
- Size: 360 (L)mm

GT-3340

$179.00

DEAL

Buy both for $280 & SAVE $28!

10A 12VDC MOTOR SPEED CONTROLLER KIT

Ideal for controlling 12VDC motors in cars such as fuel injection pumps, water/air intercoolers and water injection systems. Use it for headlight dimming and for running 12VDC motors in 24V vehicles.

- Includes PCB and all electronic components
- Output can increase to 20A with an extra MOSFET available separately ZT-2450 $9.95
- PCB Dimensions: 69 x 51mm

KC-5225

WAS $24.95

$19.95

SAVE $5.00

Kit of the month!

MINI WATERPROOF HD VIDEO RECORDER

Record every turn, twist and jump with this waterproof HD mini camcorder. Strap it onto your vehicle, head, goggles or helmet and start recording directly in 720P high definition video to a MicroSD card (not included) with up to 32GB of storage and up to 2 hours of recording time. Light weight and durable. Great for capturing all your motorsports, water sports, cycling, skateboarding or hunting adventures. Recharges via a USB cable included.

- Video compression: H.264
- Resolution: 3MP
- Battery: Li-polymer 500mAh
- Battery life: 1.5-2 hours
- Water resistance: 10m
- Dimensions: 78(L) x 22(Dia)mm

QC-3256

$199.00

NEW 2011

Helicopter Spy Camera

A tiny camera that weighs less than 30 grams! Designed to mount on a RC helicopters, planes, cars or hovercrafts. Features a ball swivel lens and delivers recorded video straight to your computer via a mini USB port. 4GB internal memory gives about 4 hours of video.

- Shockproof construction
- 90 degree viewing angle
- 60 degree lens rotation
- Mounting bracket included
- Size: 80(L) x 19(Dia)mm

QC-3820

NEW 2011

$129.00

4 CHANNEL DVR KIT WITH 4 OUTDOOR CAMERAS

These DVR kits are becoming common to homes and businesses alike as they offer exceptional value and all round day and night visual access to your premises. This DVR comes with 500GB of storage for over 300 hours of continuous video recording, as well as four cameras to cover all important areas. Also supports backup via USB drive. Live recording can be initiated manually or pre-programmed via Smart Phone/iPhone® (via installed app) or the internet, and log into your system from anywhere and view live and recorded footage.

DVR Features:

- Video compression: H.264
- Alarm notification via email
- Automatic recovery after power failure
- Video loss alarm
- Password protection
- PTZ compatibility via RS-485 port
- Mains power supply included.
- Dimensions: 300(L) x 210(W) x 50(H)mm

$599.00

Camera Features:

- Outdoor weatherproof enclosure
- Infrared LEDs for Day/Night operation
- Integrated mounting bracket
- Sensor: 350TV Lines CMOS
- Cable length: 18m (video & power in one)
- Dimensions: 85(D) x 58(Dia)mm

QV-3026

NEW 2011

ECONOMY ACTIVE 12" SUBWOOFER

This 12" Subwoofer in a sealed enclosure has a built-in amplifier to match. The unit produces a whopping 75WRMS of astounding bass. Equipped with line level and high level inputs, it also has built-in fuse protection and wired remote level control.

- Bass boost: 12dB
- Gain: 18dB
- Power output: 75WRMS
- Dimensions: 425(W) x 355(H) x 360(D)mm

CS-2269

$99.00

DEAL

Buy 2 for $175 Save $23

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Gifts & Gadgets

MUMS KITCHEN GADGETS

Kitchen Voice Recorder

Mum can use it for her shopping list, as a reminder for the kids or even to record the ingredients in those quick cooking commercials when she can never find a pen to write them down. Strong magnetised backing.

- 3 folders up to 50 messages
- Digital clock
- Requires 2 x AA batteries
- Measures 130(L) x 66(H) x 17.2(W)mm

XC-0249 WAS $69.95

$39.95
SAVE $30.00

Kitchen Scales with Clock & Temp/Humidity

Kitchen scales, clock and weather station rolled into one. It weighs up to 3kg (6.6lb) in metric or imperial, then can be used as a wall clock that displays temperature and humidity as well. Funky orange to stand out from the appliances. Requires 3 x AAA batteries.

- Celsius & Fahrenheit display
- Kg or lb
- Size: 200(Dia) x 22(H)mm

XC-0161 WAS $44.95

$34.95
SAVE $10.00

FOR THE MUSICIAN

Acoustic Guitar with MAGIX Music Maker Software & USB Connection

A complete composition, arranging and recording package. Features steel string guitar, laminated top and sides with built-in chromatic tuner and 3-band EQ. It can be directly interfaced to a PC via USB B cable. The bundled recording software MAGIX Music Maker SE is one of the easiest and most intuitive programmes going around and will have you recording in seconds. Arrange, edit, build and mix tracks with intuitive, easy-to-use tools. Even the most inexperienced user of PC based recording will find it very easy to start recording tracks in seconds.

- No drivers required
- Compatible with Windows XP, Vista, 7
- Intuitive drag and drop software
- Chromatic tuner
- Requires 1 x 9V battery
- Mac compatible
- Spare strings available separately CS-2558 $14.95

CS-2559 WAS $249.00

$199.00
SAVE $50.00

DEAL
Buy both for $250 & SAVE $68.95!

NEW

20W Guitar Practice Amp

A groovy little practice amp with enough volume for the odd garage jam. It has a headphone jack, switchable distortion for that Hendrix effect and a metal grille to protect the speaker. Ideal entry-level guitar amp.

- 5.25" speaker
- CD input
- Headphone jack
- Mains powered
- Dimensions: 250(W) x 315(H) x 205(D)mm

CS-2554 WAS $69.95

$59.95
SAVE $10.00

USB SLIDE/FILM SCANNER

Convert your negatives and slides to digital images quickly and easily with this USB scanner. Images are scanned in about half a second for high-speed conversion and editing using the included Arcsoft Photoimpression software or one of many other image management programs.

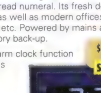
- Colour or B&W film or slides
- Negative and slide holders included
- 1,800 dpi resolution
- USB Powered
- Dimensions: 85(W) x 165(H) x 90(D)mm

XC-4881 WAS $99.00

$74.00
SAVE $25.00

SOLAR POWERED WINDMILL

A novel item that reminds us of the importance of sustainable renewable energy. It looks like a windmill, but is actually solar powered. Shine a bright torch on its solar panel and watch the blades spin - the brighter the light the higher the RPM.



- Base measures: 65(L) x 65(W)mm
- Height: 160mm

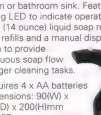
GT-3754

$16.95

NEW

BLUE LED WALL CLOCK

Eye-catching LED wall clock with bright blue numeric display. 2.5-inches tall and easy-to-read numeral. Its fresh design will suit contemporary homes as well as modern offices, workshops, waiting rooms etc. Powered by mains adaptor with a 9V battery for memory back-up.



- 12/24 hour mode with alarm clock function
- Remote control and mains adaptor included
- Dimensions: 310(W) x 33(D) x 164(H)mm

AR-1759 WAS $69.95

$59.95
SAVE $10.00

iPOD® SPEAKERS FOR MUM

iPod® Shuffle Speaker with Aux-In

Designed for the 2nd generation iPod® Shuffle, this stereo speaker is still ideal for use with any iPod® or MP3 player. It produces quality 1W+ 1W power output sound. Features a protective cover, making it great for use at the beach.

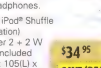
- Requires 4 x AAA batteries
- Size: 190(W) x 80(H) x 20(D)mm

XC-5189 WAS $19.95

$6.95
SAVE $13.00

iPod® Shuffle/MP3 Active Desktop Speaker

This little four speaker beauty is the ideal way for you to listen to your MP3 or iPod® Shuffle music without the need for headphones.



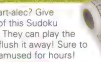
- Recharges iPod® Shuffle (1st Generation)
- Total Power 2 + 2 W
- Plugpack included
- Measures: 105(L) x 105(H) x 60mD)mm

XC-5188 WAS $59.95

$34.95
SAVE $25.00

SUDOKU TOILET PAPER

Know a smart-alec? Give them a roll of this Sudoku toilet paper. They can play the game then flush it away! Sure to keep them amused for hours!



- Double ply

GH-1508

$5.95 Per roll

DEAL
Buy 2 for $8 & SAVE $3.90!

MINI RECHARGEABLE USB KEYCHAIN SPEAKER

For whenever you want to share your music on-the-go. Compatible with any device that features a 3.5mm headphone socket such as iPods, MP3 players, PDAs, portable games and computers. It comes with a USB connection included to recharge the built-in battery. The ultimate in portability.

- USB and 3.5 - 3.5mm cable included
- Measures: 25(W) x 25(H) x 25(D)mm

XC-5178 WAS $19.95

$14.95
SAVE $5.00

ALL FOR MUM THIS MOTHERS DAY

Sports Stopwatch

This water resistant handy sports timer will be a useful addition to mums sports bag.

- Split time, alarm and calendar function
- Includes 600mm lanyard
- Dimensions: 55(W) x 65(H) x 15(D)mm

XC-0270 WAS $12.95

$9.95
SAVE $3.00

Dual Sided Magnifying Mirror

This dual sided mirror has one mirror at 1 x magnification and the other at 5 x magnifications. The frame is rimmed with an LED light making it ideal to use at night or in poor light conditions.

- Mirrors measure: 110(Dia)mm
- Requires 3 x AA batteries
- Unit measures approx 180(L) x 110(W) x 200(H)mm

GH-1067 WAS $24.95

$19.95
SAVE $5.00

Automatic Liquid Soap Dispenser

Functional and stylish additions to any kitchen or bathroom sink. Features a blinking LED to indicate operation, a large 410ml (14 ounce) liquid soap reservoir for fewer refills and a manual dispensing button to provide continuous soap flow for larger cleaning tasks.

- Requires 4 x AA batteries
- Dimensions: 90(W) x 130(D) x 200(H)mm

GH-1187 WAS $24.95

$19.95
SAVE $5.00

USB Pink Keyboard

Mum will love this chic pink keyboard featuring 21 hot keys including three ACPI keys for easy access to the internet, email and multimedia applications. Don't get stuck with a boring keyboard, be outrageous and go pink!

- Measures: 30(H) x 480(W) x 180(D)mm

XC-5151 WAS $35.00

$25.00
SAVE $10.00

PRE-CUT HEATSHRINK TUBING - TRADE PACK

Glue lined heatshrink in an array of sizes to suit all needs - 60 pieces in total. Supplied in see through nylon snap shut case.

$29.95

- Box measures: 205(W) x 108(D) x 35(H)mm

WH-5521

NEW JULY

COMPRESSION CRIMPING TOOL FOR F-TYPE PLUGS

A compact compression tool designed for our Foxtel approved F-type plug (PP0708). A channel accurately positions the plug, and a spring-loaded clamp holds the cable in position. These features and leverage action of the handle ensure easy F-type compression crimps can be performed quickly and easily time after time.

- Dimensions: 143(L) x 22(W) x 45(H)mm

TH-1803

$29.95

NEW JULY

HEAVY DUTY CABLE STAPLE GUN KIT

Take the pain out of cable installation. Simply staple the cable to eaves, rafters or joists. The staples have an integral plastic cable clamp that holds the cable firmly in place. Includes heavy duty die cast gun, 3 interchangeable blades and 200 staples in a carry case.

TH-2615 WAS $49.95

$39.95

SAVE $10.00

Cable staples refill 8 - 9mm
Pk 200 TH-2616 WAS $9.95 **NOW $7.95** SAVE $2.00
Cable staples refill 9.5 - 11mm
Pk 200 TH-2617 WAS $9.95 **NOW $7.95** SAVE $2.00
Cable staples refill11.5 - 12.5mm
Pk 200 TH-2618 WAS $9.95 **NOW $7.95** SAVE $2.00

F-CONNECTOR TOOL SET

All the tools you need for cutting, stripping and crimping F-connectors for coax cable installations.

The kit includes:

- Coax cable stripper
- Compression crimp tool
- Heavy duty cable cutter
- 10 x F-59 plugs
- Nylon storage case: 152(W) x 220(H) x 45(D)mm

TH-1804 WAS $79.95

$49.95

SAVE $30.00

USB OSCILLOSCOPES

2 Channel USB Oscilloscope

Using the Plug 'n' Play USB technology, this oscilloscope is easy to setup and use, as well as providing protection for the computer. The software is a fully featured chart recorder, function generator, logic generator, logic analyser, and spectrum analyser all in one easy to use package. See website for specifications.

- Oscilloscope, spectrum analyzer
- Sample rate: 100 Hz - 200 kHz
- Input voltage: -20 - +20 V
- ADC capacity: 10 bits

QC-1930 WAS $299.00

$199.00

SAVE $100.00

48W TEMPERATURE CONTROLLED SOLDERING STATION

Ideal station for the advanced hobby user. Features analogue temperature adjustment, ceramic element and a lightweight pencil that will give you hours of fatigue-free soldering. The stand has spare tip storage and is very sturdy.

- Power: 48W
- Temperature range: 150 - 450°C
- Operating voltage: 24V
- Dimensions: 150(L) x 115(W) x 92(H)mm

TS-1564

$99.00

NEW JULY

Spare parts available:

Spare pencil	TS-1565	$39.95
Spare tips: 0.5mm Conical	TS-1566	$9.95
2.0 mm Conical	TS-1567	$9.95

LEAD-FREE SOLDERS

99.3% tin, 0.7% copper lead-free. Sizes for every application from hobby to industry.

0.71mm 12g Hobby Pack
NS-3086 $2.95
0.71mm 200g Roll
NS-3088 $17.95
0.71mm 500g Roll
NS-3090 $42.00

FROM $2.95

1mm 15g Hobby Pack
NS-3092 $2.95
1mm 200g Roll
NS-3094 $17.95
1mm 500g Roll
NS-3096 $42.00

NEW JULY

TRUE RMS CAT IV DIGITAL MULTIMETER

Designed for professional use and provides many years of reliable service. Measures up to 1,000 volts AC & DC and is rated to Cat IV 600. The meter includes temperature and capacitance ranges, as well as peak-hold and min/max options. It is water and dust-proof (IP67) and features a double moulded case. Includes K-type thermocouple.

- Special features: Backlight, data hold, peak hold, min / max hold, relative measurement, bargraph, IP67
- Dimensions: 182H) x 82(W) x 55(D)mm

QM-1543

$149.00

40MHz USB Digital Storage Oscilloscope

A PC-based digital storage scope for less than the cost of an analogue CRO. PC-based instruments are the way to go - smaller, lighter and cheaper, they offer as-good or better performance than the analogue equivalents, with the advantages digital operation offers, such as trace storage and memory capability. Probes included. See website for specifications.

- Automatic setting to trace parameters
- AC or DC coupling
- External trigger input
- One-button data export to Excel
- Storage formats: .TXT; JPEG, BMP, MS Word or Excel
- Dimensions: 188(L) x 98(W) x 30(H)mm

QC-1931 WAS $399.00

$299.00

SAVE $100.00

MUM WILL FIX IT!

149 Piece Pink Tool Set

Every tool the handy super mum could ever possibly need. The kit contains a hammer, long nose pliers, multigrips, tape measure, screwdrivers, shifting spanner, shears, driver with 20 bits, 8-piece Allen key set, 6 jewellers' screwdrivers plus an assortment of nails, screws and other fasteners. An easy to follow how-to booklet is included on each tool and common household tasks. Finished in bright pink.

- Case measures: 250(W) x 322(H) x 65(D)mm

TD-2075 WAS $49.95

$39.95

SAVE $10.00

23 Piece Mini Pink Tool Kit

For mum that likes to be prepared for every situation, here's a mini tool kit she can take anywhere. And. . . it's pink! These are good quality tools with rubberised grips to protect her most delicate hands! See in-store or website for full list of tools.

TD-2067 WAS $19.95

$14.95

SAVE $5.00

Don't forget May 8th Mothers Day

DIGITAL THERMOMETER FOR FRIDGE OR FREEZER

No more spoiled food. This thermometer will set off an alarm when your fridge or freezer goes above or below set temperatures.

- Mounting hardware included
- Requires 1 x AAA battery
- Dimensions: 67(W) x 39(H) x 15(D)mm

QM-7209

$19.95

FRIDGE / FREEZER THERMOMETER

LOW COST DMM

Perfect first multimeter! This is a full featured meter with plug-in 4mm probes and transistor tester. Gives you years of reliable service, you will only need to replace this meter if you require a unit with very high input impedance. At this price you should buy two!

- 3.5 Digit
- 10A DC Current
- Dimensions: 125(H) x 68(W) x 23(D) mm

QM-1500

$9.95

DEAL

Buy 2 for $15 & SAVE $4.90!

FLAMMABLE GAS DETECTOR

When a flammable gas is detected, this unit will provide audible and visual annunciation via its in-built buzzer and LEDs. Simple to use and operate, it's perfect for checking gas bottles while camping or caravanning.

- Detectable gases: LNG and LPG
- Includes 2 x AAA batteries

QM-1660 WAS $69.95

$39.95

SAVE $30.00

Car Reversing Cameras

CAR VIDEO EVENT RECORDER

This handy device is automatically activated by the built-in 3-axis G sensor that responds to a sudden change in wheel speed. It starts recording the event to an SD card (16GB stores up to 5hrs - card not included). Simply mounts onto the windscreen like a GPS unit. Ideal for fleet operators, taxis, hire cars, or just the everyday person on the road.

- 120° wide-angle camera with IR LEDs
- Supports SD cards
- Video resolution: 640 x 480 @ 30 fps
- Real time clock stamp
- Video output for external monitor
- Dimensions: 92(W) x 80(H)mm

QV-3796

$249.00

Don't forget May 8th Mothers Day

AUTOMOTIVE WATERPROOF PLUG & SOCKET SETS

NEW 2017

Commonly used on many modern cars for wiring connections within the engine bay and other areas that are exposed to moisture. The interlocking parts are surrounded by a rubber seal, while an individual grommet seals each wire. Each package includes plug, socket, cable grommets and crimp pins.

- Current rating: 20A (max.)
- Pin spacing: 7.5mm
- Assembled Length: 70mm

2-Way	PP-2110	$7.95	FROM
3-Way	PP-2112	$10.95	$7.95
4-Way	PP-2114	$16.95	
6-Way	PP-2116	$19.95	

UNDER SEAT ACTIVE 8" SUBWOOFER

Add some bottom end to your car audio! The compact size of this amplified subwoofer means it will fit under a seat and is robust enough to take some knocks. Ideal for utes, convertibles and trucks.

- Power output: 55WRMS
- S/N ratio: 70dB
- Variable gain: 0 - 18dB @ 50Hz
- Dimensions: 360(L) x 250(W) x 80(H)mm

CS-2286 WAS $159.00

$129.00 SAVE $30.00

CIGARETTE LIGHTER BATTERY MONITOR

Check the voltage output of your vehicle's main battery quickly and easily. Simply plug this handy voltmeter into the cigarette lighter socket and get an instant LED readout of the electrical system's voltage.

- Display resolution: 0.1V
- Accuracy: +/- 2%
- Operating voltage: 8 - 30VDC

QP-2220

$19.95

UNIVERSAL GPS CHARGER WITH DUAL USB OUTPUT

This handy universal GPS charger not only works as a replacement for an original GPS charger, but having two USB outputs allowing you to charge both your GPS and your mobile phone at the same time. Supplied with 1.2m USB charging lead and 6 replaceable connectors to suit most GPS models.

- Suitable: TomTom, TomTom XL, Navmen, Garmin, Magellan, Navigon, Falk, Mio, etc
- Input: 12-24VDC
- Output: 5VDC, 3.0A max total
- Dimensions: 100(L) x 42(W) x 25(H)mm

MP-3676

NEW 2017

$29.95

MP3 FM MODULATOR WITH REMOTE

This unit will play MP3 tracks directly through your car stereo through the FM band. Music can be stored on an SD/MMC card, USB memory stick or an external media player (iPods, MP3 players) can be plugged in via the auxiliary input. Powered from either 12V or 24V source.

- Backlit LCD
- Accepts SD/MMC, USB or aux input
- 12 - 24VDC operation
- Dimensions: 130(L) x 40(W) x 25(H)mm

AR-3120

NEW 2017

$14.95

REVERSING MONITOR AND CAMERA

Car Dash-Mount 3.5" LCD Colour Monitor

Mounts perfectly on your vehicles dashboard. This 3.5" TFT LCD colour monitor folds down into a compact shell for dust-protected storage and keeps your driving line-of-sight unobstructed. With two video inputs, the rear vision view is automatically activated when your reversing gear is engaged. You can even connect it to a DVD player.

- Crisp high resolution display
- TFT active matrix system
- Includes RCA cable & adhesive mounting sticker
- Power supply: 12VDC 8W

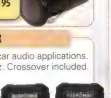
QM-3771 WAS $99.00

$89.00 SAVE $10.00

DEAL: Buy both for $149 Save $39.95

Flush Mount Mini Waterproof Camera

Reversing into tight spots, or parking in low light underground car parks is fraught with danger so any extra information is going to help. A lengthy 5m composite RCA cable and the appropriate sized hole saw are included making this colour CMOS camera easy to install.



- Camera dimensions: 31(L) x 20(Dia)mm

QC-3513

$89.95

SILK DOME CAR TWEETER

25mm silk dome tweeter for car audio applications. Smooth response up to 20kHz. Crossover included.

- Impedance: 8 ohms
- Frequency response: 1kHz - 20kHz
- Sensitivity: 91dB
- Power handling: 80WRMS
- Crossover dimensions: 72(L) x 39(W) x 21(H)mm

CS-2211 WAS $24.95

$19.95 SAVE $5.00

REAR VIEW MIRROR TFT MONITOR WITH CAMERA

A complete rear-view safety package including a 7" TFT LCD monitor and a flush mount weatherproof camera. It has adjustable spring-loaded brackets to fit different sized mirrors. Composite video input. Includes slimline remote control, 5-metre video/power cable and 28mm holesaw for camera mounting.

- 7 inch screen
- Mirror Dimensions: 260(L) x 108(H) x 50(D)mm

QM-3762 WAS $249.00

$179.00 SAVE $70.00

Note: Should not be used as a substitute for a conventional rear-view mirror but ideal when view is blocked by trailer or caravan.

7"TOUCH SCREEN LCD MONITOR WITH USB

Touch screen capabilities enables use with a laptop/PC, games console and other VGA operating devices. Use it to control a computer or any other USB compatible device. The monitor can be mounted either on the bracket or flush mounted with cradle. Software and adaptor cables included.

- Dimensions: 178(W) x 122(H) x 30(D)mm

QM-3744

$249.00

2.4GHz REVERSING CAMERA KITS

2.4GHz Rear View Mirror Reversing Camera

Wireless technology makes for easy installation. The monitor fits securely over your existing rear view mirror and can be quickly removed when needed. The brackets are adjustable so it will fit mirrors from 55 - 85mm wide and it's powered by plugging it into a cigarette lighter socket. It incorporates a reversing camera that transmits video signals via 2.4GHz to the monitor so there's very little wiring to be done. The camera can be mounted internally or externally.

- 3.5" built-in LCD
- Range: 80m
- Power: 12VDC
- Dimensions: 280(L) x 95(H) x 26(D)mm

QM-3795

$199.00

2.4GHz Wireless Reversing Camera and LCD Monitor

The LCD on this unit plugs straight into your car's cigarette lighter socket and receives video via 2.4GHz wireless band from the reversing camera. Transmission range is up to 80m, so it is suitable for very large motorhomes, trucks or caravans.

- 3.5" built-in LCD
- Range: 80m
- Power: 12VDC
- Dimensions: 110(W) x 76(H) x 21(W)mm

QM-3796 WAS $199.00

$149.00 SAVE $50.00

All Savings are based on Original RRP Limited stock on sale items.

LED CREE® TORCH WITH ADJUSTABLE LENS

With a massive light output of 190 lumens, a tactical switch and multiple light modes every 4WD should have one in the glove box. Featuring an adjustable beam that allows you to focus the light on objects at varying distances or to widen the beam for more distributed light.

- Splash resistant
- Carrying strap included
- Requires 3 x AAA batteries
- Dimensions: 106(L) x 34(W) x 27.5(D)mm

ST-3456

$34.95

Don't forget May 8th Mothers Day

CREE® LED RECHARGEABLE SPOTLIGHT

Super bright LED spotlight with 247 lumen output switchable between half and full power output. AC and 12VDC car charger are both included so it's ideal for marine, camping and other outdoor activities. LEDs indicate battery status, it has an emergency SOS mode, as well as a handy flip-up work stand for changing tyres etc. Robust ABS construction.

- CREE® LED
- Work stand
- Battery level indicator
- Weatherproof
- Multi brightness modes
- Size: 225(L) x 130(Dia)mm

ST-3309

NEW 2011

$49.95

LED CAP LIGHT

This 5 LED light clips onto a baseball cap and provides a brilliant white light. Perfect for those who prefer a simple head-lighting solution while outdoors.

- Burn Time: Up to 18 hours
- Output: 9 Lumens
- Operated by 2 button size CR2032 batteries included

ST-3281 WAS $16.95

$14.95

SAVE $2.00

Note: Cap not included

2011 Engineering Catalogue Out Now!

Over 500 pages

NEW exciting products

Grab a copy now!

ALKALINE/NI-CD/NI-MH BATTERY CHARGER

Now you can recharge AA or AAA alkaline batteries 10-20 times depending on their quality, age and condition as well as recharge Ni-Cd or Ni-MH batteries. LEDs indicate charge status and the on-board electronics prevent overheating or overcharging.

- Charges up to 4 x AA or AAA alkaline, Ni-Cd or Ni-MH batteries
- Microprocessor controlled to prevent overcharging
- Individual charge circuits for each cell
- Mains powered
- Dimensions: 71(W) x 118(H) x 30(D)mm

MB-3568

NEW 2011

$49.95

MAINS TO CIGARETTE LIGHTER SOCKET

A handy solution for powering 12V equipment such as car coolers, camping fridges, etc. from a mains AC power source. Supplied with a 1.5m output lead with cigarette socket output, making connection simple and easy.

- Input voltage: 240VAC
- Output voltage: 12VDC
- Output current: 7.5A
- Dimensions: 157(L) x 90(W) x 57(H)mm

MP-3575

NEW 2011

$39.95

5-IN-1 JUMP STARTER-INVERTER-CHARGER-COMPRESSOR-WORK LIGHT

Far more than an average jumpstarter this unit has an impressive set of features for many different uses. Tucked in on either side are two tough insulated battery clamps for all your jumpstarting needs, on the front panel are the 2 x 12VDC cigarette lighter sockets for operating 12V appliances, a 5 LED worklight and two dial indicators for air pressure and charge status. Powered by the internal 12V 18Ah SLA battery, it even has a 400W inverter to charge your laptop, etc. and a 260psi air compressor. See website for specifications.

- Dimensions: 220(L) x 215(W) x 295(H)mm

MB-3594

$149.00

FOR THE MUM ON THE GO!

150W Inverter with USB Outlet

This compact modified sine wave inverter plugs into your car's cigarette lighter socket to produce 230VAC at 150W. Also has a USB port to charge or power MP3 player or other USB operated devices.

- Dimensions: 150(L) x 75(W) x 40(H)mm

MI-5125 WAS $44.95

$34.95

SAVE $10.00

12V Notebook Power Supply

Simply plug this universal notebook power supply into your car's cigarette lighter socket and you can run or charge your laptop without the need for mains power. Supplied with a range of plugs and will suit most notebooks on the market. See our website for full specifications and notebook compatibility.

- Switchable output voltage from 15VDC to 24VDC

MP-3463 WAS $39.95

$29.95

SAVE $10.00

Multifunction 200W Inverter

Housed in a tough rubberised case, this is the ideal power accessory for your next camping, fishing or 4WD adventure. In addition to a 200W modified sine wave inverter, it also provides a USB outlet, an LED work light and two 12V cigarette lighter outlets.

- Dimensions: 230(W) x 180(H) x 62(D)mm

MI-5103

$69.95

Retractable USB Multi Charger Kit

Charge a multitude of different phone or media player devices from any USB port and eliminate the need to cart a mains powered adaptor around. Suits just about everything, including PDAs and cameras. 15 adaptors included see website for full listing. Ideal for mums on the go.

XC-3510

$24.95

PORTABLE FOLD-UP SOLAR PANEL KITS

Excellent for your next camping, 4WD or boating trek, this fold away solar panel and charging kit allows you to easily charge your batteries (not included) allowing you to run power, lights, TV etc wherever you stop. Each model features alligator clamp connections on a 4m lead, has the charge controller included so you can connect directly to your battery without fear of over-charging, and is supplied with a heavy duty metal carry handle and latches, plastic protective corners and a durable nylon carry bag. Three sizes to choose from, all are 12V.

40W Folding Solar Panel
ZM-9132 $399.00

80W Folding Solar Panel
ZM-9130 $649.00

120W Folding Solar Panel
ZM-9134 $899.00

FROM $399.00

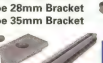
Solar Panel Mounting Hardware

We've arrived at a range of solar panel mounting hardware that is adaptable and modular to fit most applications.

FROM $19.95

Solar Panel Aluminium Extruded Rail	1m	HS-8702	$39.95
Solar Panel Aluminium Extruded Rail	2m	HS-8700	$69.95
Joiner Bracket	80mm	HS-8714	$19.95
L-Type Bracket	Pk 2	HS-8704	$34.95
Z-Type 28mm Bracket	Pk 4	HS-8706	$79.95
Z-Type 35mm Bracket	Pk 4	HS-8708	$79.95
T-Type 28mm Bracket	Pk 2	HS-8710	$39.95
T-Type 35mm Bracket	Pk 2	HS-8712	$39.95

HS-8708



HS-8710/12

HS-8700

Digital Ready

LCD MONITOR WALL BRACKETS

Getting the right viewing angle with LCD screens with fixed wall brackets is nearly impossible. Now we have an adjustable LCD screen wall bracket, which can tilt and swivel to get the best possible viewing angle. Suits any LCD screen which uses the industry standard VESA mount fittings.

LCD Monitor Wall Bracket

- Mounting System: VESA 50x50, 75x75, 100x100
- Max weight: 5kg
- Tilt up/down and swivel 120°

CW-2814 WAS $39.95

$29.95
SAVE $10.00

Double Arm LCD Monitor Bracket

- Mounting System: VESA 50x50, 75x75, 100x100,100x200
- Max weight: 22kg
- Tilt up/down and swivel 160°

CW-2813
WAS $69.95

$59.95
SAVE $10.00

91 ELEMENT UHF ANTENNA

Huge antenna suitable for deep fringe signal reception. Excellent performance on both analogue and digital signals. Features waterproof F-type PCB balun, water resistant, and metal boom and reflectors. Easy to assemble.

DIGITAL READY

- Elements: 91
- Gain: 15 - 19dB
- Channels: 21 to 69
- Bands: 4 & 5
- Boom Width: 20mm sq
- Overall Length: 2214mm

LT-3182

$89.95

INDOOR TV AMPLIFIER/SPLITTER

Boost your TV signal indoors. The antenna lead is plugged into the amplifier, and there are two outputs for two TVs, or one can be used for FM stereo if desired, both have a 12dB boost.

- Runs on 240VAC mains
- Includes a LED power indicator

LT-3288

$49.95

STEREO DAB+ FM RADIO

Still got an analogue radio? Upgrade to the infinitely superior DAB+ format for instant station selection, digital clarity, crystal clear stereo sound, zero interference as well as song and artist information on a bigger range of stations. 6 x AA batteries required or use the included AC adaptor.

- DAB+ or FM
- 10 station presets
- Clock and alarm
- 3.5mm headphone outlet
- 2 x 2WRMS output
- Dimension: 220(W) x 110(H) x 100(D)mm

AR-1756 WAS $89.00

Note: DAB+ Not available in all areas

$79.00
SAVE $10.00

WATCH FOOTY ALL OVER THE HOUSE!

Yes, not cheap, but definitely the best. If you want to send wireless high definition HDMI signal, this is the product for you. Simply connect the transmitter to the HDMI equipped TV in the remote location. This device lets you enjoy the benefits of watching Pay TV in the bedroom, in full-HD quality without expensive cabling and installation. Includes IR sender/repeater.

- IR remote extender built-in
- HDCP 2.0 and CEC compliant
- HDMI 1.3 compliant
- Up to 1080p/60Hz video resolution (full HD)
- On-screen status display
- Dimensions: 180(L) x 140(W) x 39(H)mm

AR-1875
WAS $449.00

$399.00
SAVE $50.00

FOOTY IS BACK

HD DIGITAL TV SET-TOP BOX WITH USB RECORDING

Get digital ready with this high definition set top box unit. It incorporates a USB port for AV program recording as well as playback. Navigation is simple and easy with the full function remote control. Outputs are HDMI, component video, composite video and stereo analogue audio.

- Supports up to 1080i resolution
- Remote requires 2 x AAA batteries
- Dimensions: 220(W) x 140(D) x 42(H)mm

XC-4917 WAS $99.95 Not available in NZ

$79.95
SAVE $20.00

FREE Jaycar Bulldogs Ball (HB-5012) With Any Purchase On This Page

JAYCAR

HDMI ESSENTIALS

5-Input HDMI Switcher

This five input HDMI selector routes high definition video and audio signals from the selected input to the HDMI output. Fully HDCP compliant and comes with an infrared remote control. It has a gain control to compensate for long cable runs and includes a mains adaptor.

- 5 x HDMI inputs
- Fully HDMI and HDCP compliant
- Size: 270(W) x 170(D) x 50(H)mm

AC-1693 WAS $99.95

$69.95
SAVE $30.00

HDMI Cable Tester

Designed to check and troubleshoot the pin connections of Type A HDMI cables quickly and easily. Ideal for testing the continuity of each signal pin of an HDMI cable prior to installation. Requires 9V battery.

- Carry case included
- Dimensions: 215(L) x 38(W) x 36(H)mm

AA-0406
WAS $149.00

$79.00
SAVE $70.00

CONTROLS FOOTY IN THE PALM OF YOUR HAND

Universal Learning Remote with A/C Control

Pre-programmed with thousands of devices, and able to learn and control up to 8 different devices including AV equipment & air conditioners.

- Backlit LCD
- Requires 3 x AAA batteries
- 2 macro functions
- Low battery indicator
- Dimensions: 200(L) x 56(W) x 26(D)mm

AR-1726 WAS $37.95

$24.95
SAVE $13.00

Touchscreen 8 in 1 LCD Remote Control

Program up to 8 devices in your home entertainment system. Use the learning function or pre-programmed code library to enrol each component, or use the macro functions to program up to 100 keystrokes. The LCD backlight is colour coded for easy recognition.

- Requires 4 x AA batteries
- Dimensions: 195(L) x 65(W) x 21(H)mm

AR-1728 WAS $59.95

$49.95
SAVE $10.00

Right Angle HDMI Adaptors

Adapts HDMI plug to socket at right angles. Perfect for wall mounted TV applications. Gold plated connections.

Two types available:

Right Angle Down HDMI Adaptor
PA-3646

$12.95

Right Angle Up HDMI Adaptor
PA-3648

$12.95

HDMI Leads with Extender

These affordable HDMI cables have built-in equaliser boosting the signal strength to enable cable lengths of 10m, 15m and 20m without the use of external power supply. Cables are ATC certified and fully V1.4 compliant. Supports 120Hz refresh rate.

FROM **$99.00**

10m	WQ-7403	$99.00
15m	WQ-7408	$139.00
20m	WQ-7409	$199.00

HDMI Wall Plates with Flylead

Comes with a single or dual HDMI port with flexible flylead for better inner wall clearance. Standard Australian/NZ GPO mount with HDMI sockets for AV installations.

Single HDMI Wall Plate Socket
PS-0281

$14.95

Double HDMI Wall Plate Socket
PS-0283

$19.95

DMX LASER LIGHTING

DEAL
Buy both for $298 save $50

Green DMX Laser Show

Applying the latest technology, this laser projector is ideal for bars, clubs, house parties or family functions. It produces over 100 green patterns with sound activation or DMX master/slave control. Light weight and portable.

- Sound and power active indicator
- Mains powered
- Control mode: Sound active, automatic, DMX512 (7 channels), master/slave
- Power rating: 20W
- Dimensions: 205(L) x 80(W) x 145(H)mm

SL-3436

$199.00

ACTIVE AMP SPEAKER KIT

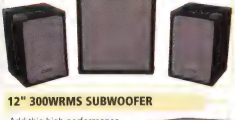
A complete DJ, karaoke or music sound system in one package with a 12" active sub (150WRMS) and a pair of 2-way 8" satellite speakers (100WRMS). The amp/sub enclosure has a 4 channel mixer that takes inputs from any device that connects to line level RCA, XLR or 6.5mm inputs. Also record to a computer or digital multi-track recorder via the RCA line outputs. Two Speakon 4 metre cables are included. See in-store or website for specifications.

- Dimensions: 410(W) x 520(H) x 460(D)mm

CS-2545 WAS $949.00

MASSIVE SAVINGS!

$699.00
SAVE $250.00



12" 300WRMS SUBWOOFER

Add this high performance subwoofer to your existing system and really get a boost to your music system's low frequency performance. Finished in leatherette vinyl and houses a 12" four ohm sub-woofer rated at 300WRMS. Perfect for boosting the bass frequencies of music systems in bars, clubs, and parties etc.

- Impedance: 4 ohms
- Frequency Response: 40-180Hz
- Enclosure Size: 480(W) x 580(H) x 440(D)mm

CS-2518

$199.00

DEAL
Buy 2 for $370 SAVE $28

19" Rack Mount DMX Controller

Control multiple DMX devices, such as lights, dimmers, fog machines or laser shows with pre-programmed scenes such as fade, pan, strobe, colour etc. limited only by the capabilities of the actual DMX devices. Rack-mountable and mains powered. Visit our website for more information and programming tips.

- Control up to 12 devices
- 16 channels per device
- Standard 19" rack mount
- 9V plugpack included
- Dimensions: 482(W) x 133(H) x 70(D)mm

SL-3429

$149.00

Don't forget May 8th Mothers Day

GREEN LASER STAR PROJECTOR

Projects thousands of dazzling green laser star like formations and comes with an integrated amplified speaker to connect an iPod® or MP3s to blast tunes through the stars. To complete the ambience, it also has colour changing LEDs which can be set to beat with the music or one of the four colours (red, green, blue and white).

- 6W Motion light
- HDSS noise filter technology
- Dimensions: 140(L) x 140(H) x 110(D)mm

SL-2931

$119.00

RCA TO USB DIGITAL CONVERTER

Suitable for converting any line-level audio device to USB for stereo PC recording. RCA to USB converts analogue to digital audio in high resolution. Simply install Magix Audio Cleaning Lab SE & Audacity software included to import your music & optimise sound recording quality.

- 16-bit 44.1kHz digital audio output
- Gold plated terminals
- Recording software included
- Suitable for PC & MAC
- Cable Length: 1.2m

GE-4050

$49.95

NEW

8-PORT PARALLEL SPEAKER HUB

Controls for up to eight pairs of stereo speakers. Its lightweight compact chassis make it suitable for wall mounting. Screw terminals handle wire sizes 12-24 gauge. Note that every speaker pair must be connected to an impedance-matching volume control and set to the same magnification.

- Weight: 246g
- Dimensions: 196(L) x 94(W) x 29.5(H)mm

AC-1663 WAS $49.95

$34.95
SAVE $15.00

IP65 SEALED ENCLOSURES WITH MOUNTING FLANGE

Designed to IP65 of IEC529 and NEMS 4 (dust and hose proof). The lid and base incorporate a tongue and groove sealing system with a neoprene gasket. Wall mounting holes and lid fixing screws are outside the sealing area thus preventing the ingress of moisture and dust.

IP65 Sealed ABS Enclosures

- Made with ABS material
- Moulded in dark grey

HB-6125 $19.95
Box: 171(W) x 121(D) x 55(H)mm
Base: 201(W) x 121(D)mm

HB-6127 $14.95
Box: 115(W) x 90(D) x 55(H)mm
Base: 145(W) x 90(D)mm

IP65 Sealed Polycarbonate Enclosures

- Made with Polycarbonate material
- Moulded in light grey

HB-6217 $16.95
Box: 151(W) x 90 (D) x 55(H)mm
Base: 145(W) x 90(D)mm

HB-6219 $21.95
Box: 171(W) x 121(D) x 55(H)mm
Base: 201(W) x 121(D)mm

FROM $14.95

NEW

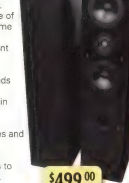
HB-6125

JV60 6.5" 3 WAY SPEAKER KIT

JV60 6.5" 3 Way Speaker Kits – 150WRMS

With the return of the Vifa drivers, we are proud to re-introduce the JV60 speaker kit. By investing a couple of hours of your own time to build this superb system to compliment most mid-powered amplifier/ receivers, you can save hundreds over commercial speakers. Kit is sold in two parts; speaker components and mounting accessories and pre- built speaker cabinets. Both have enough components to build a pair of JV60s.

$499.00



JV60 Speaker Kit with Crossovers & Accessories - Pair

- Speaker kit includes woofers, tweeters, crossovers and mounting accessories.
- 4 x 6.5" Vifa P17WJ (see CW-2106 for specs), cast magnesium basket, mineral filled polycone woofer
- 2 x Vifa D25AG (see CT-2020 for specs), aluminium alloy diaphragm, Ferro fluid cooled tweeter
- 2 x 3-way, Linkwitz-Riley filter with polyswitch protection and impedance equalisation

CS-2560 $499.00 pair

JV60 Prebuilt Cabinets - Pair

- Bass reflex design with corner frequency of 35Hz
- Pre-built with all holes cut for components
- Finished in "blackwood" veneer
- 1090(H) x 260(W) x 260(D)mm (50L internal volume)

CS-2562 $199.00 pair

Pre-assembled JV60 Complete - Pair

We are also offering a fully assembled version if you just don't have the time but still want to experience the quality performance of this design.

CS-2564 $899.00 pair

Place your order in-store and we'll build it for you.

19" RACK MOUNT CABINETS

Ideal for studios, PA, sound reinforcement, IT, or phone systems installations. These 19" rack cabinets offer outstanding features. All come in 1.8mm solid steel powder coated cabinets with clear tempered glass doors. The sides can be removed and panels are key-lockable.

FROM $139.00

6U Rack Mount Enclosure

Dimensions: 530(W) x 360(H) x 450(D)mm
HB-5170 WAS $179.00 **NOW $139.00** SAVE $40.00

9U Rack Mount Enclosure

Dimensions: 530(W) x 493(H) x 450(D)mm
HB-5172 WAS $219.00 **NOW $169.00** SAVE $50.00

12U Rack Mount Enclosure

Dimensions: 530(W) x 626(H) x 450(D)mm
HB-5174 WAS $259.00 **NOW $199.00** SAVE $60.00

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100% Arduino compatible board that can talk to the world. Do Twitter updates automatically, serve web pages, connect to web services, display sensor data online, and control devices using a web browser. Any project you would previously have built with an Arduino and an Ethernet shield stacked together, you can now do all in a single, integrated board. See website for more details.

- Gold-plated PCB
- Top and bottom parts overlay
- Top-spec ATmega328P MCU
- Rounded corners

XC-4216

$69.95

LINE INTERACTIVE UPS SYSTEMS

Protect valuable computer systems and critical data from black-outs, brown-outs and power surges. It will constantly monitor the mains supply and switch to battery power and enable the system to be shut down without data loss. Supplied with a 7Ah SLA battery for 3 minutes back-up time at full load, USB interface cable and software. 650 or 1500VA models available.

- Supply voltage 220 to 280VAC
- Output voltage 220VAC

360W 650VA Line-Interactive UPS

- Dimensions: 382(L) x 124(W) x 225(H)mm

MP-5201 WAS $129.00 **NOW $109.00** SAVE $20.00

750W 1500VA Line-Interactive UPS

- Dimensions: 382(L) x 124(W) x 225(H)mm

MP-5203 WAS $299.00 **NOW $279.00** SAVE $20.00

FROM $109.00

USB NXT SOUNDBAR SPEAKERS

Featuring high performance NXT flat panel drivers in a package small enough to fit in your notebook bag. Powered by USB, these plug-and-play speakers dramatically outperform inbuilt notebook speakers. Provides high quality sound in a portable take-anywhere package. A great accessory recommended to all notebook users.

- Dimensions: 220(L) x 70(H) x 45(D)mm

XC-5199 WAS $49.95

$19.95

SAVE $30.00

INSERTS FOR KEYSTONE WALLPLATES

A range of inserts to cater for computer and audio video applications. They fit standard 110 keystone wallplates and allow you to configure your installation any way you like.

Toslink - Toslink PS-0749
PS-0749 $3.95

USB - USB Female PS-0753
PS-0753 $6.95

3.5mm Stereo Socket PS-0777
PS-0777 $2.95

eFLASH PORTABLE PRESENTATION CONSOLE

Massive Savings!

eFlash allows you to present common Microsoft Office applications without the need for a computer. It connects easily to a projector or TV and is operated by the included remote control with integrated laser pointer. Presentations are played from an SD memory card. Supports Microsoft Word, Excel, PowerPoint, PDF, Macromedia Flash, JPEG formats.

- Auto slide show
- Displays up to 640 x 480

XC-5405 WAS $199.00

$54.00

SAVE $145.00

MUM LOVES PINK!

Pink USB Roll-up Keyboard

These flexible USB roll-up keyboards are excellent gift for mum at home or office. Features dustproof and splash resistant surfaces, slimline profile, soft-touch keys and made from a high-quality silicone material. It's portable and can withstand all kinds of abuse.

- USB Powered
- Win 2000/ Me/XP compatible

XC-5143
WAS $24.95

$9.95

SAVE $15.00

Rhinestone USB 4 Port Hub

This pink and white USB 4 port /hub is sure to add some style and class to mums boring old desk. Simply plugs into the computer's USB ports. Combine with pink keyboard (above) for the desk everyone talks about.

- 90mm lead
- USB 2.0 compliant

GH-1898 WAS $29.95

$19.95

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5.5" GRAPHICS TABLET

Using a graphics tablet is completely natural, more comfortable and far more accurate than a mouse. The pen has user defined buttons and "hotspots" around the border of the tablet. Paint, draw, write or touch up. Absolutely essential tool for graphics designers, photographers or other creatives.

- Battery and software included
- Windows 2000, XP, Vista or Mac
- Dimensions: 205(W) x 190(H)mm

XC-0356 WAS $79.95

$59.95

SAVE $20.00

HOUSEHOLD PROJECTS - BUILD THEM!

Tempmaster Fridge Controller Mk II

Turn an old chest freezer into an energy-efficient fridge or beer keg fridge. Or convert a standard fridge into a wine cooler. These are just two of the jobs this low-cost and easy-to-build electronic thermostat kit can do without the need to modify internal wiring! Used also to control 12V fridges or freezers, as well as heaters in hatcheries and fish tanks. Short-form kit contains PCB, sensor and all specified components. You'll need to add your own 240V GPO, switched IEC socket and case.

- PCB Dimensions: 68 x 67mm

KC-5476

$32.95

Temperature Switch Kit

This kit operates a relay when a preset temperature is exceeded and drops-out the relay when temperature drops. Ideal as a thermostat, ice alarm, or hydroponics applications, etc. Adjustable temperature range of approx - 30 to +150 degrees Celsius.

- Kit includes NTC thermocouple.
- 12VDC

KG-9140

$24.95

433MHz Remote Switch Kit

Suitable for remote control of practically anything up to a range of 200m. The receiver has momentary or toggle output and the momentary period can be adjusted. Up to five receivers can be used in the same vicinity. Short-form kit contains two PCBs and all specified components.

- PCBs: Tx: 85 x 63mm Rx: 79 x 48mm

KC-5473

Extra transmitter kit available separately: KC-5474 $22.95

$44.95

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Arrival dates of new products in this flyer were confirmed at the time of print. Occasionally these dates change unexpectedly. Please ring your local store to check stock details. Prices valid to 23rd May 2011.
All savings are based on original RRP

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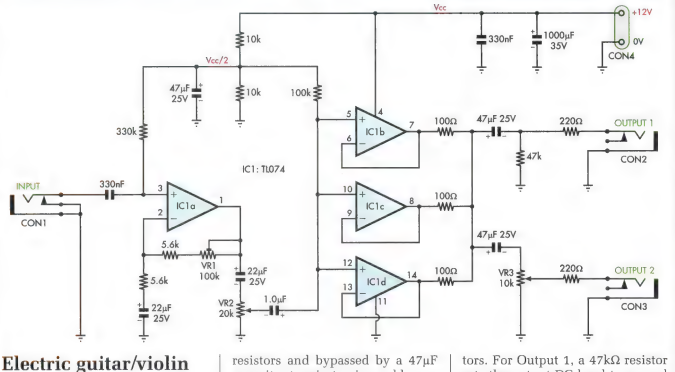
CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.



Electric guitar/violin preamplifier

Magnetic pick-ups in musical instruments have a relatively high output impedance. This can result in a reduction in treble response when connected via a long cable run or to equipment with a low input impedance.

This preamplifier provides a high input impedance and a low impedance output, solving both issues. It has adjustable voltage gain and can run off a battery or DC plugpack.

The input signal is AC-coupled to the non-inverting input of IC1a, part of a TL074 quad op amp. This has JFET input transistors and the input impedance is set by a 330kΩ bias resistor which also sets the DC level at this input to half supply (Vcc/2). This is generated by a voltage divider comprising two 10kΩ resistors and bypassed by a 47µF capacitor to reject noise and hum.

IC1a is configured as a non-inverting amplifier with a gain of between 2 and 20, depending on the setting of VR1. IC1a's output is fed to VR2 via a 22µF capacitor, allowing the output volume to be set. The audio then passes to the non-inverting inputs of the remaining three op amps (IC1b-IC1d) which are connected in parallel to provide a low output impedance; it will drive a load impedance as low as 600Ω.

The 100Ω resistors in series with the outputs provide short-circuit protection for the op amps and also prevent large currents from flowing between the outputs in case they have slightly different offset voltages.

The buffered signal is then AC-coupled to two output connectors using 47µF electrolytic capacitors. For Output 1, a 47kΩ resistor sets the output DC level to ground and a 220Ω series resistor provides further short-circuit protection. Output 2 is similar but includes another potentiometer (VR3) to allow its level to be set individually.

Note that this means the impedance of Output 2 can be high (up to 2.5kΩ depending on the position of VR3's wiper).

The total harmonic distortion of this circuit is typically less than 0.01% with the gain set to six.

If a TL064 is used instead of a TL074, the current drain will decrease but there will be more noise at the output.

Finally, the input impedance can be increased by increasing the value of the 330kΩ resistor to suit high-impedance pick-ups.

Petre Petrov,
Sofia, Bulgaria. ($80)

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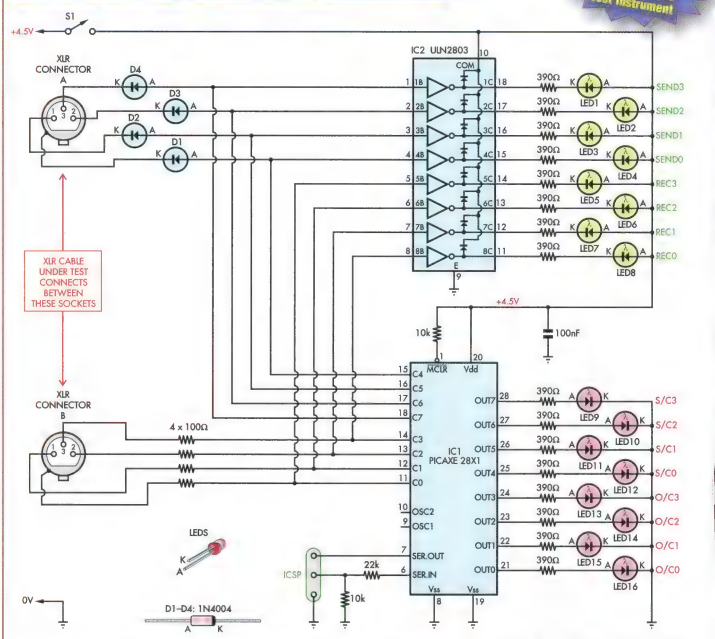
Phillip Webb is this month's winner of a Peak Atlas Test Instrument!



PICAXE-based automatic multi-core cable tester

This circuit uses a PICAXE 28X1 microcontroller to automatically test multi-core cables. It was designed primarily to test microphone cables with XLR connectors (ie, three cores plus screen) but could be easily adapted for other cables and connectors.

The principle of operation is that the PICAXE micro sequentially applies a send voltage to each core and the receiving end voltage is measured on all cores. The send and received voltages are indicated by the green LEDs. The receiving end voltage is checked for short circuits or crossovers and open circuits and displayed via the red LEDs. Any red LED indicates a cable fault.

On closing switch S1, the PICAXE commences the first of three operating modes. The first is a "LED test" routine that lasts about a second and applies voltage to all cores. If all cores are continuous then all LEDs should be lit. If any of the receive LEDS are not lit then that immediately indicates a faulty cable.

Next is automatic mode, where the cores are sequentially tested at a fast rate. Following this fast test, each core is tested at a slow rate for a short period to permit observation of the send and receive LEDs. If all is well, the corresponding receive LED should light whenever a send LED is lit.

Testing then alternates between slow and fast until the unit is powered down or switches to low-power mode. The cable and connectors under test should be repeatedly moved during the test in order to detect any latent or intermittent faults.

After five minutes of continu-

Data logger based on OpenLog µSD board

The OpenLog is a small circuit board which carries a micro-SD (µSD) card connector, some ICs and pin headers. It runs off a 3.3-12V supply and makes it very easy to interface a PICAXE micro to a µSD card for data logging.

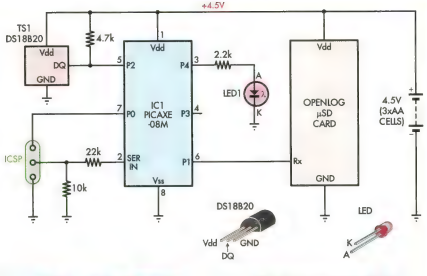
This circuit shows a sample application which combines a PICAXE-08M with an OpenLog and a temperature sensor. It runs off three AA cells and saves the temperature reading to a CSV (comma separated variable) file on the memory card. The temperature is logged in degrees Celsius, once per minute.

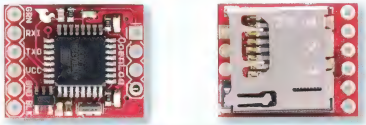
The temperature sensor is a Dallas DS18820 with a 1-wire digital interface. The PICAXE microcontroller spends most of its time in sleep mode, for one minute at a time. When it becomes active, it turns LED1 on, retrieves the temperature reading from the sensor (TS1), writes this to the µSD card and then turns LED1 off and goes back to sleep.

Data is written to the OpenLog using a 1-wire serial port. It supports baud rates from 2400 up to 115,200. The serial port is configured by the contents of a file called CONFIG.TXT (must be all capitals) on the memory card. For this project, communications is at 2400 baud so the file should contain this line:

2400,26,3,1

The OpenLog board is available from Little Bird Electronics at **http://littlebirdelectronics.com/products/OpenLog.html** and at the time of writing costs $25.





The OpenLog board (shown here larger than life-size) makes it easy to interface a PICAXE micro to a µSD card for data logging.

The software for this example application is available as a download from the SILICON CHIP website (openlog.bas). The OpenLog could also be used as a debugging aid for PICAXE projects, since it is easy to write messages onto the memory card using a single pin.

For more advanced applications, the OpenLog can be put into "command mode" by sending three control-Z characters in a row (ASCII 26). Commands can then be sent which control which file is being written to and so on. It consumes just 2mA at idle and 6mA when continuously recording.

Terry Simmich,
Brisbane, Qld. ($55)

ous operation, a low-power mode is automatically invoked. Cycling the power switch resets this mode. To conserve power, the unit should always be powered down using the power on/off switch. When in low power mode, the ground open circuit LED flashes periodically.

Note that it is normal for the metallic shell of each XLR connector to be connected to the screen (terminal or core 1). The unit does not flag a short if these connections are both made. If either or both shell connections are not connected, an open-circuit LED will be lit for core 0.

Because both the grounds are normally connected to the screens at each XLR connector, the status of the ground open circuit LED cannot differentiate which ground end is open but this can be determined by observing the send and receive LEDs for the ground and screen.

An easy-to-interpret front panel would involve arranging the LEDs in a 4 x 4 matrix, with left to right columns of Send, Receive, Short and Open and the rows representing the cores.

Diodes D1-D4 prevent overloads on the PICAXE outputs in the event of a core-to-core short. The ULN2803 Darlington driver array (IC2) is used to drive the send and receive LEDs and thus buffer the cable cores under test. This ensures that the PIC output ports are not subject to overload in the event that multiple cores are shorted and many of the LEDs are lit. The ICSP header provide a simple programming interface.

Finally, pins 11, 12, 13 & 14 of the PICAXE 28X1 are connected to pins 0, 1, 2 & 3 on the XLR connector via 100Ω resistors. These prevent overloading of the PICAXE outputs if a short occurs between the connections.

Phillip Webb,
Hope Valley SA.

Flexitimer modification gives adjustable on and off-delay settings

This modification to the Flexitimer (*Electronics Australia*, March 1991) provides two different delay settings, one for on-time and one for off-time. A switch is added which determines which of these is active at any given time.

The original Flexitimer waits for a time period determined by potentiometer VR1 in combination with the position of a link, the latter selecting one of the outputs of a ripple counter. After that period, it energises its on-board relay and remains in that state until it is manually reset.

With this circuit, the off-time is still set using VR1 but there is also an on-time setting, controlled by potentiometer VR2. When the off-time period expires and the relay is energised, nothing happens until switch S1 is toggled. The timer then counts for the on-time period before switching the relay off again. If S1 is then toggled again, the process repeats.

The other alteration allows the operation of the relay to be inverted. This is determined by which of two additional links are installed. With the links as shown, relay operation is as for the original.

The circuit works as follows. If switch S1 is open, a 10kΩ resistor pulls input pin 1 of NXOR-gate IC1a to ground whereas if it is closed, pin 1 is pulled high via a 470Ω resistor. The 100nF capacitor debounces the switch and helps eliminate any glitches on IC1a's input due to noise and electromagnetic interference.

IC1a is configured as an inverter since its other input, pin 2, is connected directly to ground. So the output of IC1a is high if switch S1 is open and low if it is closed. IC1b then inverts the output of IC1a.

The output of IC1a determines which of the potentiometers (VR1 or VR2) controls the frequency of 555 timer IC2. The 1μF timing capacitor is discharged through a 4.7kΩ resistor directly into pin 7 of the IC. It is charged via the same 4.7kΩ resistor and either VR1 or VR2, depending on whether diode D1 or D2 is forward biased.

When the output of IC1a is high, the output of IC1b is low and so D2 is forward biased while D1 is reverse-biased. When the output of IC1a is low, the situation is reversed. This means that current can only flow into the timing capacitor through either VR1 or VR2, as determined by the position of S1.

As with the original Flexitimer, 555 timer IC2 drives ripple counter IC3. Only one of IC3's outputs drives the transistor that energises the relay, depending on which link is installed and so the position of this link in combination with the frequency of IC2 determines the timing period.

NXOR-gate IC1c pauses timer IC2 when S1's state changes during the timing period or when the timing period expires. Its input (pin 8) is connected to the output of IC1b and so is controlled by S1. The other input, pin 9, is connected to the output of counter IC3 which controls the relay.

If IC3's output is high and switch S1 is open, IC1c's output is low and so timer IC2 is held in reset. Similarly, if S1 is closed, the timer is reset as long as IC3's output is low. These conditions correspond to the end of the two timing periods.

Normally, IC3 controls the relay via transistor Q2. As shown, when the selected output of IC3 goes high, Q2 is turned on. This allows current to flow through relay RLY1's coil and thus switches it on. Diode D4 quenches any back-EMF spikes.

If the alternative link is installed instead, when IC3's output is low, transistor Q1 turns on and so supplies current to transistor Q2, also turning it (and thus the relay) on. Conversely, when IC3's output is high, Q1 is off and therefore so is Q2 and the relay.

Ken Moxham,
Urrbrae, SA. ($70)

Editor's note: if IC3's output is connected to pin 2 of IC1a (rather than being connected to ground) the relay will be continually switched with the on and off-periods determined by VR1 and VR2 in combination with the counter link.

In this configuration, switch S1 can be used to pause or resume the timer.

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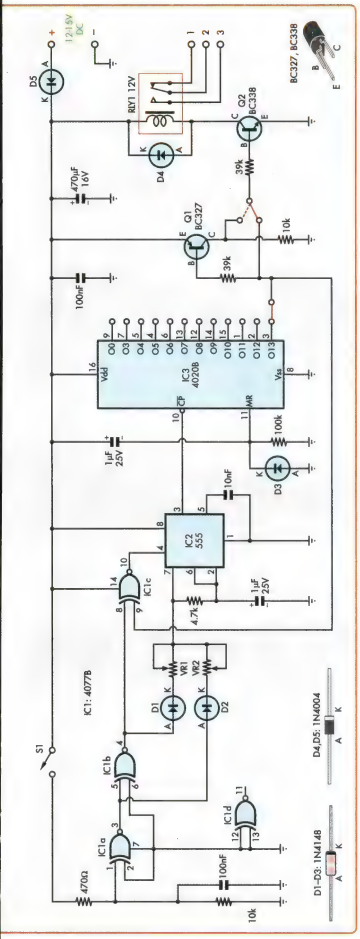

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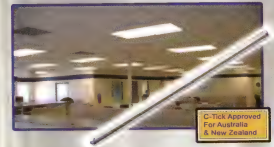

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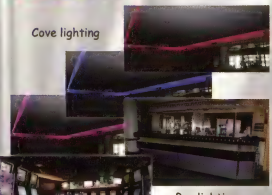

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Memory card compatibility issues

by Nicholas Vinen

An increasing number of SILICON CHIP projects use memory cards for storing data, loading software and the like. Originally intended for digital cameras, mobile phones etc, these cards are small, now quite inexpensive and can store an enormous amount of data (8 and 16GB cards are now common). But as some readers have discovered, there can sometimes be issues . . .

Many of our projects provide an interface with a memory card for data storage. These include the Music and Speech Recorder (August 2009), the Webserver in a Box or WIB (November 2009 to January 2010), the DAB+/FM Tuner (October to December 2010), the Digital Lighting Controller (October to December 2010) and the USB Data Logger (December 2010 to February 2011).

The memory cards used with these projects can be MultiMediaCards (MMC; up to 16GB), Secure Digital (SD; up to 4GB) or Secure Digital High Capacity (SDHC; up to 64GB).

Mode

In each case, we interface with these devices in "1-bit" mode, which is like the Serial Peripheral Interface (SPI) protocol.

It is a 4-wire bus utilising a clock line (driven by the micro), two lines for bidirectional serial data transfer and a chip select line, to activate the memory card and indicate the start and end of data packets.

In the later model MMC cards and for all SD and SDHC cards, there is also a "4-bit mode" which provides faster data access and an expanded set of commands.

Virtually all computers and most other devices which require high speed data transfer (eg, digital still and video cameras) use this mode. The 1-bit mode is provided primarily for use with microcontrollers, to reduce overhead and complexity.

Some readers have reported that certain memory cards do not work in these projects.

We have previously released firmware updates for some of these projects to address bugs in the memory card routines, for example some early versions did not work with 2GB SD cards.

These cards report information in a different way to all other SD cards and the early software versions did not include a special case to handle them. All of our current firmware releases incorporate this fix.

However, some cards were still not being properly recognised. One reader kindly sent us the SD card in question so that we could figure out what was going on.

Ultimately we tracked the bug down to what seems to be an error in the memory card controller itself. We suspect that this is not normally noticed since it only seems to affect operation in 1-bit (SPI) mode.

Updated firmware is now available for all the previously mentioned projects on the SILICON CHIP website.

They contain a work-around which allows these problematic memory cards to be used with our projects. The DAB+/FM Tuner and Digital Lighting Controller contain software "bootloaders" which allow the firmware to be updated without any special tools.

For the other projects, a programmer (such as the PICkit3) will be needed to install the updated code.

Here is a quick explanation of how the memory card communication works, the problems we found and how we worked around them.

Memory card protocol

To send a command, the microcontroller brings the chip select line low and then sends 48 bits of data. The data bits are received by the card on the positive edge of each clock pulse. A sample command sequence, for command 17 (block read) is shown in Fig.1.

The first byte (eight bits) contains

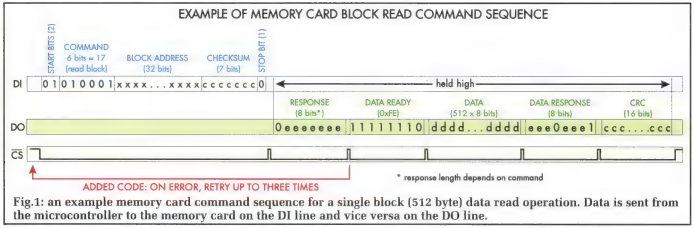

Fig.1: an example memory card command sequence for a single block (512 byte) data read operation. Data is sent from the microcontroller to the memory card on the DI line and vice versa on the DO line.

two start bits and then the command number (0-63).

Following this is four bytes (32 bits) of data, which for a block read command contains the address of the data block to be read. This is followed by a seven bit checksum and finally a stop bit.

The checksum allows the card to detect command transmission.

After a command is sent, the microcontroller reads back one or more bytes; how many depends on which command was sent.

For a block read, the result is a single byte and this indicates whether there is an error. A response of all zeroes indicates that the command is successful and that data will follow.

The microcontroller then continually reads eight bits from the card, waiting for the data transmission to be ready. This allows the card to move data into buffers as necessary.

For write commands, the delay is usually longer as it takes time to erase and prepare the FLASH memory for writing.

Once the card is ready, it transmits a "token" bit sequence (in this case, 0xfe).

When that token is received, the micro can read the 512 bytes of data from the block requested. The data is followed by another status response and a 16-bit data checksum. The card is then ready for another command.

One complication with the read/write procedure has to do with addressing. SDHC cards use block addressing, so address 0 indicates the first 512 bytes, address 1 the next 512 bytes, etc.

MMC and SD cards use byte addressing so to read the second set of 512 bytes, the address to be passed is 512, rather than 1.

Problematic controller

So what is it that goes wrong with this process with the troublesome SD cards?

Actually, the first read operation completes successfully and the checksum is correct. The data returned is all valid. The first block read we perform in our software involves reading the first blocks on the card (block 0) which contains the partition table.

Once the partition table has been read, we then need to read the first block of the first partition to check what file system it is using.

On some cards, this second block read fail. The 8-bit response we receive immediately after the command is 00111111.

This is a nonsense error code which would seem to indicate that the card is in "idle state" and "erase reset" state simultaneously and that four errors have also occurred: illegal command, CRC error, erase sequence error and address error (see Fig.2).

It is hard to see how it is possible to have an "erase sequence error" when we are not writing to the card.

Adding a delay between the first and second block read doesn't make this error go away, so it does not seem to be due to the memory card being busy.

BLOCK READ RESPONSE FORMAT

0	
0	Parameter error
1	Address error
1	Erase sequence error
1	Communications CRC error
1	Illegal command
1	Erase reset
1	In idle state

Fig.2: the meaning of each bit for the 8-bit response to a block read command, showing the problematic error state.

The solution to this strange situation is straightforward: when we get an error after a read command (even if it's a nonsensical one), we immediately repeat the same command again.

Our test card always succeeds when we attempt the read a second time.

Rather than looking for this specific error condition we simply retry each command up to three times if it fails for any reason.

That should also cover situations where a communication glitch (eg, due to noise) causes occasional command failures. After making this change, the problem card worked reliably.

Other controller bugs

There is one additional wrinkle. Before we could discover and fix the problem described above, we had to fix another problem that is also specific to this particular model of card (or controller). This only occurred with the DAB+/FM Tuner firmware.

Since the tuner does not have a connection to the switch in the card socket which indicates whether a memory card is present, it periodically sends a command to the card to check that it is still there.

The command selected has no side effects; its sole purpose is to establish that the card is still there and communicating normally.

Originally the command used was CMD9, which reads the Card-Specific Data (CSD) register. This contains information on the format and capabilities of the memory card. This command is normally used during memory card initialisation but it should be possible to send it again later.

In this case, the command sent during initialisation is successful but if

it is sent again later, the memory card locks up completely and no longer responds properly to any command.

This includes the reset command, so it is necessary to remove power to the memory card to get it working again.

The fix for this problem is simply to use CMD13 to check for card presence instead of CMD9. CMD13 reads the card status register instead and this does not cause the same problem.

We have yet to find out why sending CMD9 should cause the card to lock up but we assume that it's the result of the same faulty controller logic that causes the problem with block reads.

The fact that this particular SD card exhibits two mystifying errors which other cards typically do not suggests strongly that the problem is in the card, rather than our software.

Installing the new firmware provided for each of these projects will allow the use of these problematic cards.

We have had several readers report that the changes were successful in allowing the use of a memory card which previously did not work, suggesting that the controller problem is not especially rare. SC

USB Data Logger firmware improvements

We recently made some improvements to the firmware for the USB Data Logger (December 2010 to February 2011) in addition to the memory card related fixes. These were alluded to in the errata published last month but here are some additional details.

Firstly, while tracking down a power supply problem, we noticed that when power was initially applied to the data logger (eg, when the battery is inserted), it often went into the USB bootloader mode even though pushbutton S2 was not being held down at the time. This was especially the case when the battery voltage was on the low side but sometimes happened even with higher battery voltages.

The reason for this is that the state of pushbutton S2 was being sensed using a digital input pin and S2 is multiplexed with the battery voltage sensing resistors. When S2 is pressed, pin AN4 of IC1 is pulled to ground and so if used as a digital input (RA5), it registers as low (zero). But when S2 is not pressed, it will only be pulled up to a maximum of half the battery voltage. If the battery is 3V then this is 1.5V.

But the datasheet says that for digital input pins with a TTL buffer (which includes RA5/AN4) and a 3.3V micro supply voltage, the minimum voltage to reliably read a pin as high is 1.625V. This is unlikely to be exceeded with any two cell AA battery. So the firmware would often read the state of S2 as being pressed even when it was not.

To solve this, we changed the code to instead use the ADC to measure the voltage at pin AN4 when power is first applied, after a short delay, to allow the voltages to stabilise. It now only considers S2 to be pressed when the resulting voltage reading is very close to zero and this results in much more reliable detection of the state of S2. As a result, it no longer goes into bootloader mode when it should not.

Initial clock source

We also made some changes to the initial clock source for the micro. This is related to the power supply and it reduces the current drawn at start-up and with a low battery voltage.

Because the micro is driven from a boost regulator that runs off the battery, as the battery voltage drops the current drawn from it increases. If the voltage is low enough then the ratio of battery current to micro supply current can become quite high and so even quite modest supply current drawn by the micro in this condition can present a significant load to the battery.

This compounds the problem because internal resistance in the battery will make its voltage drop even further under heavy load. Because the firmware puts the micro to sleep when the battery voltage is low, it might seem like this is not an issue but it is for two reasons.

Firstly, when the battery voltage drops low enough, the micro voltage also drops and this causes it to reset. When it is reset it is no longer in sleep mode but if the voltage is low enough, it can not start up properly and so will not go back to sleep. It gets stuck in "limbo" and this can cause excessive current drain from the battery which will flatten it completely.

Secondly, the micro does not go into sleep mode immediately if the battery voltage is low. First it must go through the start-up procedure and spend some time sampling the battery voltage before it decides to go to sleep. So even if the micro does manage to start back up after a reset when the battery is low, it can still draw a lot of current initially.

Ideally, we would make the microcontroller start up using a low speed, low power oscillator such as the internal RC oscillator and then switch over to the crystal for high speed operation once it has confirmed that the battery voltage is sufficient. Unfortunately the PIC18F47J53 family does not support dynamic switching from the RC oscillator to a crystal (it can do the opposite though).

The best we could do is have the micro start up using the crystal but then immediately switch to low speed, low power operation and check the battery voltage. It waits in this state for the battery voltage to be high enough before it goes into high speed mode and goes through the full initialisation process.

Our testing shows that this approach goes a long way towards reducing current drawn from the battery at start-up, especially when battery voltage is low. It also effectively prevents the micro from getting stuck in "limbo".

Due to the way the boost regulator operates, current drain is still higher with a low battery voltage but in combination with the inductor change specified in the errata last month, it will not run the battery down as quickly as it did with the original firmware.

Low battery sleep mode

We made one more change to the USB Data Logger firmware and this has to do with how it checks the battery voltage. The original firmware would only decide to sleep if the battery voltage was low as long as a memory card was inserted and at least one script was running. While this would normally be the case, we decided that it should check the battery voltage regardless.

So we added an extra check in the main loop which will put the micro to sleep if the battery voltage is below the specified threshold, regardless of what the Data Logger is doing. This provides an extra layer of battery discharge protection. SC

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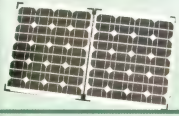

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Part 3 – by Geoff Graham

Using The Maximite

Over the past two months we introduced the Maximite, a tiny microcomputer that can turn its hand to many things, from teaching programming to controlling your greenhouse. In this final article we provide an introduction to the BASIC language running on the Maximite and show you how to use this tiny marvel for measurement and control.

Before you start, it would be worth downloading the "Maximite User Manual" from the SILICON CHIP website. The following description will give you a summary of the device but the user manual is the ultimate reference.

We suggest too that as you go through this article, if programming is new to you, that you try out each of the examples to get the feel of them.

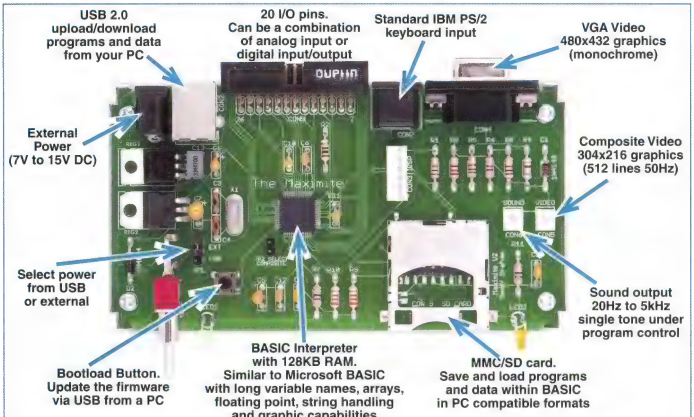
If your Maximite is completed and ready to go, you can of course use it – but if not, you can get a version of BASIC which will load and run on your personal computer. It should even be available as a free download on the net.

A few bits of BASIC

The Maximite runs the BASIC language (BASIC is an acronym for Beginner's All-purpose Symbolic Instruction Code), a very common programming language used in many computer systems. There are quite a few versions of BASIC but that used by the Maximite is fairly close to the original.

However, because it does have a couple of minor differ-

Fig.1: when you turn on the Maximite you are greeted with the prompt (>). You can try out the language simply by typing in a command and it will be executed immediately. This example shows the result of running the PRINT command with the argument of 1÷7.



The Maximite has a lot of capability built into a small package. The core component is the PIC32 microcontroller which in addition to running a powerful BASIC interpreter handles the video, keyboard, SD card, USB and sound.

ences, we've called it MMBASIC. Oh, come on now . . . **Maxi**Mite **BASIC**, OK?

When you first turn on the Maximite you are presented with a prompt as shown in Fig.1. At this point you can type in a command and try it out. This is one of the reasons that MMBASIC is so easy to learn. Almost any command can be entered in this way and you can instantly see what it does. For example:

```
> PRINT 1/7
 0.142857
>
```

The PRINT command will evaluate whatever is on its command line and display the result. In this case it evaluated the result of dividing 1 by 7 and printed the result, just like a pocket calculator.

PRINT is one of the most commonly used commands in the MMBASIC language and it comes in handy when you are experimenting with expressions and functions.

If you prefix the line with a number MMBASIC will save that line in memory along with any other lines prefixed with a line number.

You can then run the program with the RUN command. For example, type in the following:

```
> 10 A = 1/7
> 20 PRINT A
> RUN
 0.142857
>
```

Hey, you've just written your first computer "program"!

It's the same as the first example except that this time we evaluated the expression 1÷7 and saved the result in the variable "A". Then, in line 20 we printed out the value of "A". The RUN command then ran this program.

You can delete a line in memory by entering the line number without a following command and you can replace a line with a new one simply by entering the new line using the same line number. Try it out with other variables, such as

```
> 10 A = 12345-12344
```

Program lines are always executed in ascending numerical sequence so you can enter the lines in any order. And MMBASIC makes calculations following the standard rules of arithmetic/mathematics – ie, 1+2÷4 would be evaluated as 1.5, not 0.75.

You can save programs on the Maximite's SD card using

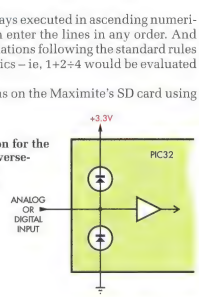


Fig.2: the input protection for the PIC32 consists of two reverse-biased diodes. These are adequate for most tasks but will not protect against a high-voltage input.

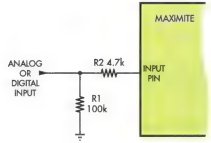


Fig.3: two additional resistors will provide extra protection for any Maximite pins configured as inputs.

the SAVE command and later load them using the LOAD command. You can also list them on your monitor with the LIST command.

Another valuable instruction is the IF ... THEN command which is used for making decisions. For example:

```
> A = 3
> IF A < 5 THEN PRINT "Less than 5"
Less than 5
>
```

The "less than" symbol (<) is used in tests like this and if the value of A is less than 5 the command following the THEN is executed. Note that in this case we did not use line numbers so the commands were executed immediately they were typed in.

Also note that we used a sequence of characters in the PRINT command. This is called a string and they can be saved in variables and manipulated in various ways. For example:

```
> T$ = "Hello"
> PRINT T$
Hello
>
```

When you use a string in your program it must be surrounded by double quotes. Also, string variables are terminated with the dollar character ($) to differentiate them from numeric variables. Other than this, strings are handled in a similar way as numbers.

Variable names in MMBasic can be up to 32 characters long and can be any mix of uppercase or lowercase characters as MMBasic ignores character case. This means that you can use descriptive variable names such as "CurrentBalance" in your program. Similarly MMBasic ignores case in commands and function names, so "print", "PRINT" and "Print" are all equivalent.

This is a very quick introduction to the BASIC language but it should show you how easy the language is to use. At the risk of repeating ourselves, to learn more you should download the "Maximite User Manual" from the SILICON CHIP website and look on the Internet for a tutorial such as the one at http://tpub.com/progintro.

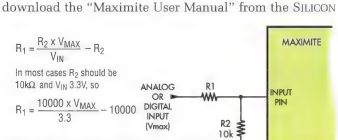


Fig.4: this circuit will be needed if the input to the Maximite will exceed 3.3V

External input/output

Before we discuss the input/output facilities of the Maximite we should warn about two events that could damage the PIC32 chip. These are static discharge and SCR latch-up.

The input/output pins on the PIC32 have some protection against static discharges. This is in the form of two reverse-biased diodes as shown in Fig.2.

These diodes will conduct (and therefore protect the inputs) if the input voltage goes above 3.6V or below -0.3V and are adequate for moderate use (for example, when soldering a connector).

However, you can still damage the chip if the static discharge is large enough (for example, if it is enough to produce a spark). That amount of energy will destroy the input circuitry and possibly the chip itself.

The other dangerous circumstance is if you force too high a current (greater than 20mA) through the protective diodes, for example by directly connecting an input to a power supply that is set to a voltage greater than the supply voltage to the PIC32. This can cause a phenomenon called SCR latch up which will instantly destroy the chip.

We could have included a protective circuit for every I/O pin in the Maximite but that would have doubled the PC board size and would have been unnecessary in the majority of applications. The solution is to be aware of these two factors and take some simple precautions.

In the case of static electricity, do not handle the I/O pins unnecessarily and make sure that you are grounded by touching the shield on the USB connector before you touch an I/O pin. In any external circuitry where an I/O pin may be floating (not connected to anything), include a 100kΩ resistor to ground to discharge any static build up.

To avoid SCR latch up you should include a series resistor of 1kΩ to 10kΩ in the input if there is any chance of the source being able to supply significant current. The input impedance of the PIC32 is quite high so a series resistance like this will not affect normal operation. Be particularly careful of circuits which might apply power to the external circuitry before you apply power to the Maximite as that is a common source of this phenomenon.

Both of these precautions are illustrated in Fig.3.

Digital input

A digital input is the simplest type of input configuration. If the input voltage is higher than 2.5V the logic level will be true (numeric value of 1) and anything below 0.65V will be false (numeric value of 0).

In the digital world, voltages between 0.65 and 2.5 are indeterminant – depending on the circuit they are in they *could* be interpreted either way or simply ignored – and should be avoided.

If the input voltage can be over 3.3V you should use a voltage divider on the input. Fig.4 shows the basic arrangement. R1 and R2 form a voltage divider and because the PIC32's input impedance is very high (leakage is less than 1μA) you could use almost any values for the resistors so long as the ratio is correct. For example, in an automobile application R1 could be 22kΩ and R2 10kΩ with the result that logic high would be any voltage above 8V.

In your BASIC program you would set the pin as a digital

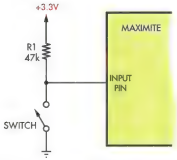


Fig.5. To detect a switch's position a pull-up resistor is required.

input and use the PIN() function to get its level. For example:

```
10 SETPIN 9, 1
20 IF PIN(9) = 1 THEN PRINT "High"
```

Line 10, with the SETPIN command, configures pin 9 as a digital input and the PIN() function will return the value of that pin (the number 1 if the pin is high). The IF command will then execute the command after the THEN statement if the input was high. If the input pin was low the program would just continue with the next line in the program.

Because the PIN() function will return 1 when the input is high and the IF ... THEN command treats any non zero number in its conditional statement as true, you could rewrite line 20 in the above code fragment to read:

```
20 IF PIN(9) THEN PRINT "High"
```

To sense the position of a switch you will need a pull-up resistor as illustrated in Fig.5. When the switch is open the PIN() function will return true and false when it is closed. A good value for R1 is 47kΩ but you could use anything from 1kΩ to 500kΩ.

I/O pins 11 to 20 have the special facility of accepting input voltages of up to 5.5V and this means that you can connect them directly to 5V circuitry without the need for voltage dropping resistors. You do not have to do anything to enable this facility, it is automatically available.

Analog input

Pins 1 to 10 can be configured to measure the voltage on the pin. The input range is from zero to 3.3V and the PIN() function will return the voltage.

Again, the SETPIN command (this time with the number 2) configures the pin (9 in this case) as an analog input. For example:

```
> SETPIN 9, 2
> PRINT PIN(9)
 2.345
>
```

You will need a voltage divider if you want to measure voltages greater than 3.3V as shown in Fig.4. Note that to retain the accuracy of the reading, the source resistance needs to be 10kΩ or less.

This means that in most circuits R2 should be 10kΩ or less. The reading also needs to be scaled in the BASIC program to allow for the voltage divider. For example, to measure a car's battery voltage you might use 39kΩ for R1 and 10kΩ for R2 giving a divide ratio of 0.2041 [R1/(R1+R2)] and a range of about 16V full scale. The BASIC program would be:

```
> 10 SETPIN 9, 2
> 20 PRINT PIN(9) / 0.2041
> RUN
 13.243
>
```

The precision of the measurement would depend on the accuracy of the resistors used for R1 and R2 and to a lesser degree the value of the 3.3V power supply to the PIC32. Rather than finding precision resistors for the voltage divider, a better approach is to simply measure the input voltage using a digital meter and use that value in the BASIC program. For example, run this program to find out the voltage measured by the Maximite on pin 9:

```
> SETPIN 9, 2
> PRINT PIN(9)
 2.983
>
```

At the same time measure the voltage at the input to the voltage divider. If you measured 13.1V on the input the resultant would be:

```
10 SETPIN 9, 2
20 PRINT PIN(9) / (2.983 / 13.11)
```

Depending on the accuracy of your meter this will give you the voltage with an accuracy approaching that of a normal digital multimeter. Too easy!

Small voltages

For small voltages you may need an amplifier to bring the input voltage into a reasonable range for measurement. Fig.6 shows a typical arrangement using the popular and inexpensive LM324 quad operational amplifier.

The LM324 can operate from a single 5V supply (as provided by the Maximite from CON8) and contains four identical amplifiers in the one 14-pin package.

The gain of the amplifier is determined by the ratio of R2 to R1 plus 1 and using the components in Fig.6 the gain is 101. This number should be used in the BASIC program so that the readings are scaled to represent the input voltage. For example:

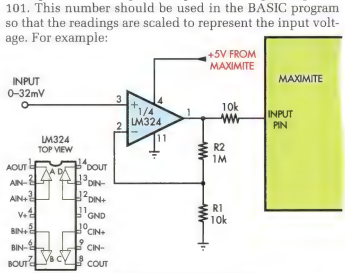


Fig.6: this simple amplifier will allow the Maximite to measure voltages as little as a few millivolts.

```
20 PRINT PIN(9) / 101
```

Again, you could just measure the input voltage and use that value to scale the input.

For better accuracy, use lower value feedback resistors to minimise bias current error. Even better would be a precision DC op amp (such as an OPA251) but the improved accuracy may be at the expense of higher power consumption.

Temperature measurement

There are many ways to measure temperature but for a simple solution the circuit in Fig.7 is hard to beat. The output of an LM335Z is a voltage proportional to its temperature. An output of 2.73V represents 0°C and a change of 10mV is equivalent to a 1°C change. The accompanying BASIC program would be:

```
10 SETPIN 9, 1
20 PRINT (PIN(9) – 2.73) * 100
```

This would print the current temperature in degrees Celsius from -40°C up to a maximum of 57°C at which point the output of the LM335Z would be at 3.3V. If you wanted to measure higher temperatures you should use a voltage divider on the output of the sensor and scale the reading in your program.

Because the output from the LM335Z has a large offset at zero degrees (2.73V) this amplifies any error in measuring the voltage. The accuracy of the Maximite's measurement is in turn dictated by the accuracy of the 3.3V supply voltage which is used as the reference when making voltage measurements.

For this reason you should measure the supply voltage of your Maximite using a digital voltmeter and use this value in your program to correct for any error. The following fragment illustrates how to do this.

```
20 V = PIN(9) * x.xx / 3.3
30 PRINT (V - 2.73) * 100
```

Line 20 measures the voltage and corrects for any error (you should substitute x.xx with the measured supply voltage). The corrected voltage measurement is saved in the variable V and then used in line 30 to calculate the temperature.

Many devices generate an output voltage that represents a physical quantity. Examples include accelerometers, strain gauges, pressure sensors and humidity sensors.

You can use this same technique to measure the voltage output from these sensors and scale the reading to a meaningful number.

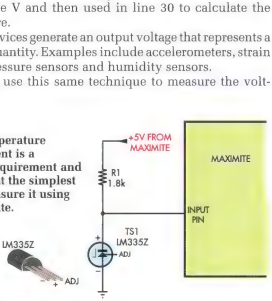


Fig.7. Temperature measurement is a common requirement and this is about the simplest way to measure it using the Maximite.

Frequency and period measurement

Again using the SETPIN command, this time with the operator 3, pins 11 to 14 can be configured as counting inputs to measure frequency, period or just count pulses on the input.

For example, the following will print the frequency of the signal on pin 11:

```
> SETPIN 11, 3
> PRINT PIN(11)
110374
>
```

In this case the frequency is 110.374kHz.

The frequency response is up to 200kHz and the measurement is returned in Hz with a resolution of 1Hz. The value is updated once a second (ie, the gate time is 1 second).

For accurate measurement of signals less than 10Hz it is generally better to measure the period of the signal. When set to this mode the Maximite will measure the number of milliseconds between sequential rising edges of the input signal. The value is updated on the low to high transition so if your signal has a period of (say) 100 seconds you should be prepared to wait that amount of time before the PIN() function will return an updated value.

Pins 11 to 14 can also count the number of pulses on their input. When a pin is configured as a counter (for example, SETPIN 13,5) the counter will be reset to zero and Maximite will then count every transition from a low to high voltage up to a maximum count of 4,294,967,295. The counter can be reset to zero again by executing the SETPIN command a second time (even though the input was already configured as a counter).

The response to input pulses is very fast and the Maximite can count pulses as narrow as 10ns (although the maximum frequency of the pulse stream is still limited to 200kHz). As an example of using this facility you could count the number of contact bounces when the switch in Fig.5 was closed. You could also count the number of objects on a conveyor belt, number of people through a door or anything that takes your fancy.

Digital outputs

All I/O pins can be configured as a standard digital output. This means that when an output pin is set to logic low it will pull its output to 0V and when set high it will pull its output to 3.3V. In BASIC this is done with the PIN command. For example PIN(15) = 0 will set pin 15 to low while PIN(15) = 1 will set it high. Incidentally, any non zero value can be used to set the output high.

When operating in this mode, a pin is capable of sourcing or sinking 10mA to 18mA (depending on the required output voltage) which is sufficient to drive a LED or other logic circuits running at 3.3V.

Pins 11 to 20 have a couple of additional properties that make it easy to connect to 5V circuitry. As already mentioned, as inputs they can be directly connected to a circuit that generates up to 5V without the need for the voltage dropping resistors.

When configured as outputs these pins can also be set

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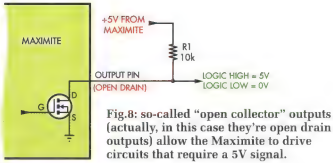


Fig.8: so-called "open collector" outputs (actually, in this case they're open drain outputs) allow the Maximite to drive circuits that require a 5V signal.

up to have an open-collector output.

Open-collector output means that the output driver will pull the output low (to zero volts) when the output is set to a logic low but will go to a high impedance state when set to logic high. If you then connect a pull-up resistor to 5V on the output, the logic high level will be 5V (instead of 3.3V using the standard output mode). The maximum pull-up voltage in this mode is 5.5V.

Fig.8 illustrates how an open-collector system works. To set an output as open collector you use the SETPIN command in BASIC (for example SETPIN 15,9 will set pin 15 to an open collector output). Note that the circuit should really be called open drain because the PIC32 uses a FET as the driver but open collector is a more common term and for consistency we will keep using it.

For driving high voltage and/or high current loads you should use an external transistor (either bipolar or FET) to drive the load.

Fig.9 provides an example of using an inexpensive power FET for driving a large load, in this case a power relay.

To provide sufficient voltage to turn on the FET, a pull-up resistor to 5V is used and the output pin is configured as open collector. This circuit can switch a load of up to 50V and 20A with the RFP30N06LE, so it could be used to drive larger loads such as the solenoid valves used in irrigation systems.

Switching mains

This is not for the inexperienced. Normally we wouldn't suggest it but we know that some readers will want to use the Maximite to switch mains devices on and off. All we can say is be careful – and if you don't know what you're doing, don't!

You could use a standard (and appropriately rated) relay to switch 230V AC (as shown in Fig.9) but a more elegant solution is to use a solid state relay such as the Jaycar SY-4080. These have full isolation between their input and output and can switch 230V AC loads with a current of up to 3A. The SY-4080 will turn on with an input level greater than 3V so it can be directly connected to a Maximite pin configured as a standard digital output. Other solid state relays may need a drive voltage over 4V and in that case you will need to use an open collector output and a pull up resistor.

Another useful output device is the reed relay. They can be directly driven by an output pin but generally they need a minimum of 5V to turn on so you would need to configure the output as open collector and connect the reed relay between 5V and the output pin.

Most reed relays can switch up to 50V at 500mA and come in a DIP plastic package (ie, they look like an IC). A reed relay should include a reverse diode between the open drain and 5V (eg a 1N4148) to prevent destroying the internal mosfet (as shown in Fig.12)

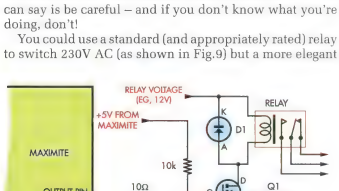


Fig.9. To drive high powered devices such as relays or solenoids a power MOSFET can be used.

Interrupts

Interrupts are a handy way of dealing with an event that can occur at an unpredictable time. An example is when the user presses a button. In your program you could insert code after each statement to check to see if the button has been pressed but an interrupt makes for a more cleaner and readable program.

When an interrupt occurs the MMBasic interpreter will execute a special section of code and when finished return to the main program. The main program is completely unaware of the interrupt and carries on as normal.

As an example, the following code fragment will detect if the user has pressed a button (connected to pin 16) and, if so, will set the output of pin 15 high (this could operate a relay or something similar).

```
10 SETPIN 15, 8
20 SETPIN 16, 7, 100
30 DO
40 ' main processing loop
50 ' more processing
60 LOOP
80 '
90 '
100 ' interrupt routine
110 PIN(9) = 1
120 IRETURN
```

In line 10 we configure pin 15 as an output (this will drive our relay or whatever) and in line 20 we configure pin 16 to be a digital input that will generate an interrupt on the high to low transition. The interrupt code starts at line 100 and this is specified as the third parameter to the SETPIN command.

Lines 30 to 60 represent the main processing loop which runs forever. If the user presses the button connected to pin 16, MMBasic will automatically interrupt the main program and execute the program starting at line 100. This routine is very short; it just sets the output high and returns from the interrupt (the IRETURN command). Meanwhile the main processing loop is completely oblivious to the interrupt.

An interrupt can be set on any pin and can be triggered on a low to high, or a high to low transition of the input.

How Good Is Your Refrigerator?

A simple demonstration of the capabilities of the Maximite is to use it to monitor the temperature regulation of your refrigerator.

This project will measure up to five temperatures within your refrigerator and also detect if the door is open or closed. This data is saved to the SD card in a format that you can load into a spreadsheet to draw graphs, calculate temperature variations and generally analyse.

Because most SD cards have a large capacity you could log the data for months to get an accurate long term picture of your refrigerator's performance.

Fig.11 shows the basic circuit. There are five temperature monitors which are based on the LM335Z temperature sensor described in the main text. The sixth input comes from an LDR (light dependent resistor) which is used to detect when the fridge door is opened. Because the circuit is so simple we built it on a piece of strip prototype board and used a length of ribbon cable with a crimped 26 pin IDC socket for connection to the Maximite.

We placed the Maximite on top of the refrigerator and ran fine wires (so as not to break the refrigerator's door seal) to the sensors inside. Two were placed in the freezer compartment (one at the back and the other at the front near the door). The remaining three were placed in the main body of the fridge – one at the top back, the second at the bottom back and the third in the middle of the door. Finally, we placed the LDR where it would be illuminated by the fridge light.

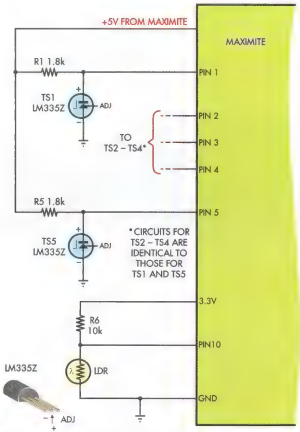


Fig.11: schematic for the refrigerator monitor and logger. Over a long period it will log up to five temperatures and the status of the door for later analysis.

```
100 FOR i = 1 TO 5 : SETPIN i, 1 : NEXT i
110 SETPIN 10, 2
120 OPEN "TEMPLOG.XLS" FOR OUTPUT AS #1
130 PRINT #1, "DATE", "TIME", "T1", "T2", "T3", "T4", "T5", "DOOR"
140 CLOSE #1
150 DO
160  OPEN "TEMPLOG.XLS" FOR APPEND AS #1
170  PRINT #1, DATE$, TIME$;;
180  FOR i = 1 TO 5
190   t = (PIN(i) / 3.3 * x.xx - 2.73) * 100
200   PRINT #1, FORMAT$(t, "%4.1f");;
210  NEXT i
220  IF PIN(10) THEN PRINT #1, "CLOSED" ELSE PRINT #1, "OPEN"
230  CLOSE #1
240  PAUSE 2000
250 LOOP
```

The BASIC program is listed above and is also available for download from the SILICON CHIP website. This will record the data into a file called TEMPLOG.XLS which can then be read by most spreadsheet software. Line 240 sets the recording frequency which is every 2000ms (or every 2 seconds) and you can change that (or anything else) to suit your requirements.

Because the temperature measurement is sensitive to the value of the 3.3V supply (which is used by the PIC32 as the reference voltage) you must measure this voltage with a digital multimeter and, before you run the program, insert its value in line 190 replacing the x.xx characters.

The program should be saved to your SD card with the name AUTORUN.BAS. This means that it will automatically start running when you apply power to the Maximite and you therefore do not need to connect a monitor or keyboard.

One important feature of the program is that it always closes the data file after any data is written (see line 230). Closing the file means that any data buffered in memory is immediately written to the SD card and that allows you to stop the recording by turning off the Maximite without corrupting the data file.

By the way, creating an Excel compatible spreadsheet file is easy.

All you need to do is write the data out as plain text with a TAB character between each data element. This is done in line 200. The comma (,) near the end of the line will output a TAB character while the following semicolon (;) tells the PRINT command to not output the normal carriage return and line feed characters.

Lines 100 and 110 setup the inputs, lines 120 to 140 write the header to the spreadsheet file and lines 150 to 250 form a continuous loop that reads the data (line 190) from each sensor and writes it (line 200) to the file. Line 240 controls how often the data is recorded.

Because there are 20 pins you can have up to 20 interrupts with each interrupt executing separate or shared sections of code. All that matters is that the interrupt routine must be terminated with an IRETURN statement.

Normally MMBasic will respond to a single interrupt within 100µs so you can use interrupts to catch reasonably fast events (for example, ignition pulses in a petrol engine).

Timing

MMBasic has a number of features that make it easy to time events and control external circuitry that needs timing.

The PAUSE command will freeze the execution of the program for a specified number of milliseconds. So, to create a 12ms-wide pulse you could use the following:

```
10 SETPIN 4, 8
20 PIN(4) = 1
30 PAUSE 12
40 PIN(4) = 0
```

Another useful feature is the TIMER function which acts like a stopwatch. You can set it to any value (usually zero) and it will count upwards every millisecond. This is handy for timing events as illustrated in the following code fragment:

```
10 SETPIN 4, 8
20 PIN(4) = 1
30 TIMER = 0
40 GOSUB 1000 ' do some work
50 IF TIMER < 12 THEN GOTO 40
60 PIN(4) = 0
```

This is similar to the previous code fragment in that it will generate a 12ms pulse but it allows your program to do some work while waiting for the pulse to finish rather than simply freezing the program's execution. Line 30 sets the TIMER to zero and then line 40 will keep calling the subroutine at line 1000 until the TIMER function has counted up to 12ms.

A very useful timing function is provided by the SETTICK command. This command will generate an interrupt at regular intervals (specified in milliseconds). Think of it as the regular "tick" of a watch.

For example, the following code fragment will save the current time and the voltage on pin 1 in a file (called "DFILE") on the SD card every second. This process will run independently of the main program which could be doing something completely unrelated.

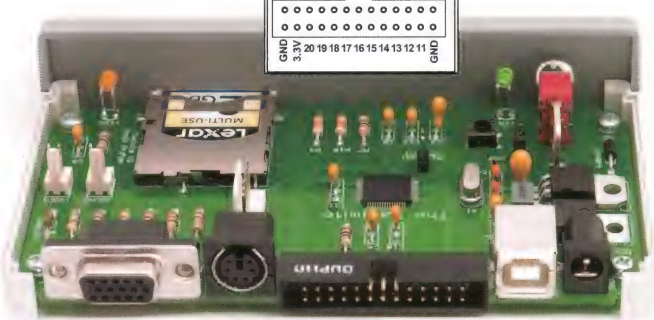
```
10 SETPIN 1, 1
20 SETTICK 1000, 500
30 DO
40 ' main processing loop
50 LOOP
60 '
500 ' tick interrupt
510 OPEN "DFILE" FOR APPEND AS #1
520 WRITE #1, TIME$, PIN(1)
530 CLOSE #1
540 IRETURN
```

Line 20 sets up the "tick" interrupt, the first parameter of SETTICK is the period of the interrupt (1000ms) and the second is the starting line of the interrupt code. Every second (ie, 1000ms) the main processing loop will be interrupted and the program starting at line 500 will be executed.

This simply appends the current reading to the data file and returns to the main program.

Loading and saving programs

When you have entered your program into the Maximite's memory you will then need to save it, otherwise it



The rear panel of the Maximite is a busy place with connectors for the VGA video, keyboard, external input/output, USB and power. Two headers on the main board provide the composite video and sound outputs. Inset at top is the input/output connector, viewed from the back (as show in the photograph). You'll need to refer to this when connecting inputs and outputs to the Maximite.

will be lost when the power is turned off. The Maximite treats the SD memory card as disk storage and there are a number of commands that you can use to save and load programs.

The command SAVE "FILENAME" will save your program in the current folder with the name FILENAME.BAS. Note that the double quotes are necessary and that MMBasic will automatically add the .BAS extension if none is supplied.

Later you could load the program using the LOAD "FILENAME" command. You can also load and run the program by adding the filename to the RUN command. For example:

```
> RUN "FILENAME"
```

As well as being run from the command input this command can be used within a running program and it enables you to launch one program from within another.

The argument to all these commands can also be a string variable, so the following fragment will run a program called "TT.BAS" from within another program.

```
10 FNAME$ = "TT.BAS"
20 RUN FNAME$
```

All file and directory names must use the 8.3 format. This means that the maximum file name length is 8 characters followed by a full stop (.) and up to 3 more characters for the file extension. File names can be in either upper or lowercase.

Unfortunately Microsoft has patented a portion of the mechanism used for long file name support with the result that we were prevented from implementing that feature.

All BASIC programs are saved to the SD card as straight text files and you can edit them using a desktop computer. If you do this you must make sure that your editor uses standard ASCII characters. This means that in the Windows world you should use Notepad and not Wordpad or MS Word, both of which embed strange characters in normal looking text.

To find out what is on the SD card you can use the FILES command. For example:

```
> FILES
Directory: \
BACKUP <DIR>
DATALOG.BAS 2090
DATALOG.XLS 8032
GRAPH.BAS 3093
HAMURABI.BAS 4362
```

The first entry in this particular listing is a directory (marked with the <DIR> symbol) and MMBasic includes a number of commands to work with these. The command CHDIR "directory" will change to a directory, for example the following code fragment will change to the directory in the previous files listing:

```
> CHDIR "BACKUP"
```

The special directory of ".." is used to change up to the parent directory. Eg, the following will change back to the parent of the BACKUP directory.

```
> CHDIR ".."
```

You can also create directories using the MKDIR command and delete them using the RMDIR command. All these commands can be used at the command prompt or within a running program.

File Input/Output

An important feature of MMBasic is the ability to save data on the SD card. To do this you must first "open" the file on the SD card using the appropriately named OPEN command.

The following example will open the file "TST.DAT" for writing:

```
10 OPEN "TST.DAT" FOR OUTPUT AS #1
```

You can then use the file number (#1) in a print command to write data to the SD card:

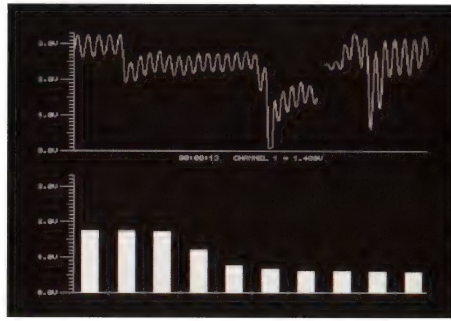
```
20 PRINT #1, VAR1, VAR2
```

Each time the print command is run it will save a line to the SD card containing the data that you specified (in this case the contents of the variables VAR1 and VAR2). When you have finished you need to close the file using the CLOSE command.

```
30 CLOSE #1
```

The close command will flush any data held in memory to the SD card and update the file records on the card to show that this is a valid file. You should never remove the SD card before the CLOSE command as that might result in a corrupt file or even render the SD card unreadable.

The above example opened the file for "OUTPUT" which means that when the file was created it would have overwritten a file with the same file name. You can also open a file for "APPEND" which means that the file will also be



An example of the graphical capabilities of the Maximite. The line graph is the voltage on pin 1 while the bar graphs show the voltage level on all 10 analog inputs. This graph can update rapidly to show the voltages in real time.

opened for writing but it will not overwrite an existing file, instead any writes to the file will be appended to the end of it.

Similar to writing to a file, you can also open a file for reading using the INPUT mode. You could then read from the file using the INPUT command as follows:

```
10 OPEN "INP.DAT" FOR INPUT AS #1
20 INPUT #1, DAT1, DAT2, DAT3
30 CLOSE #1
```

Note that the INPUT command requires that the data elements in the file be separated by commas and terminated with a carriage return/line feed combination. You can also use the LINE INPUT command to read the whole line into a string variable in one go and then pull the data line apart using the string manipulation functions in the BASIC language.

MMBasic allows you to have up to 10 files simultaneously open. For each file you would use a unique file number, for example, #1, #2, #3, etc. Other commands and functions within MMBasic allow you to delete files, rename files and tell when you have reached the end of a file.

Graphics

The old adage "a picture is worth a thousand words" is true in computer output too.

Within MMBasic you can draw fancy graphs like that shown aboove. This shows the voltage on pins 1 to 10 as a bar graph and the voltage on pin 1 as a line graph. You cannot see it in the photograph but the Maximite has enough speed to update the graph rapidly showing any variations on the inputs in real time.

The simplest graphic commands are the PSET and PRESET commands. These will turn off or on any pixel on the screen. You also have at your disposal the workhorse of the graphics commands, the LINE command which will draw either a line, or a rectangle, or a filled rectangle. The LINE command can also be used to erase a portion of the screen as well as drawing lines.

The CIRCLE command will draw a circle (actually an oval as the Maximite's pixels are not exactly square). As with the LINE command, the circle can be filled with pixels that are turned off or on. Finally there is the LOCATE command which is used to position the next output of the print command to anywhere on the screen.

All graphics commands use screen coordinates expressed in pixels. The top left hand corner of the screen is the zero position (x = 0 and y = 0) while the bottom left coordinate will vary depending on the video configuration (VGA or composite).

Possibilities

The Maximite was conceived as an enabling piece of technology, something that would enable readers to build more sophisticated devices without having to spend a lot of money and learn a specialised programming language such as C or C++.

The two boxes "How Good Is Your Refrigerator?" and "Battery Capacity Meter" give a couple of interesting examples where the Maximite could be used.

Do you have an interesting project in mind?

For up to date errata, notes and new firmware for the Maximite go to http://geoffg.net/maximite.html

Battery Capacity Meter

Another excellent demonstration of the Maximite's capabilities is to use it as the brains behind a battery capacity meter.

Like most people we have amassed a collection of AA and AAA rechargeable batteries (mostly NiMh chemistry), some of which have reached the end of their life. But, which ones? And, how good are the good ones?

It would also be interesting to test new batteries when we purchase them. Do they really match the rating printed on the outside?

You could test each battery by fitting it into a piece of equipment and timing how long it lasted before the equipment stopped - but that is tedious and not very accurate. A much better solution is to build a low cost add-on to the Maximite designed to measure a battery's capacity.

Fig.12 shows the circuit of this add-on. Each of the four reed relays can switch a load resistor across the battery and by turning on a combination of the reed relays the BASIC program can vary the load on the battery in 16 steps. At the same time, the program can determine the battery's level of charge by measuring the voltage on pin 1.

To avoid the need to purchase accurate resistors the program is designed so that you can measure the resistors using a digital multimeter and enter the values as constants into the BASIC program. The program will then use these numbers to determine what relays to turn on/off to maintain the desired load and also calculate the current drain on the battery.

Note that when you are measuring the resistance of R3 and R4 you need to measure the total resistance of the

The battery test add-on connected to a prototype of the Maximite. The reed relays and load resistors are contained in the UB5 jiffy box and connected to the Maximite via 26 way cable and IDC connector.

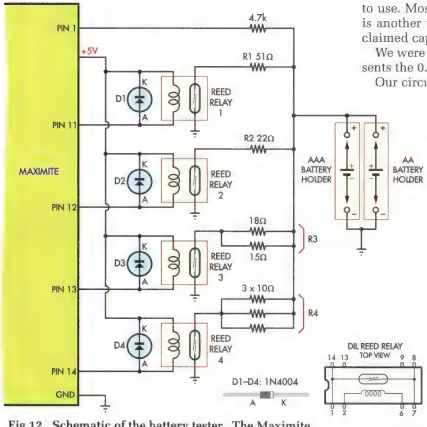


Fig.12. Schematic of the battery tester. The Maximite can control the relays to provide different levels of load on the battery while monitoring its level of charge.

paralleled resistors. At the start of the BASIC program you will find a series of assignments as follows:

```
145 R1 = 56.00
150 R2 = 22.00
155 R3 = 8.20
160 R4 = 3.33
```

This is where you need to enter the measured values for R1, R2, R3 and R4.

Note that the resistors do not need to be in an exact binary sequence (ie, 1 -2 -4 -8) as you would normally expect. The program will work with whatever values you use and calculate the combination necessary to maintain the load as near as possible to the specified value.

Using some simple calculations it is then easy to add up the current drain over time to come up with the battery's capacity in milliamp-hours.

The program is too large to list here but it is also available on the SILICON CHIP website for download. Because it is written in BASIC you can easily modify it for other tasks such as testing higher voltage battery packs or different types of batteries.

Fig.13 shows the opening screen of the program. First the program requests the current drain to use. Most batteries are tested at 0.2C or 0.1C which is another way of saying 20% or 10% of the batteries claimed capacity.

We were testing a 1000mAH battery so 200mA represents the 0.2C current drain.

Our circuit has four relays and therefore 16 different levels of load and this results in a rather coarse control of the load. That is not a concern as it will have little effect on the resulting battery capacity measurement and it is a much simpler technique than trying to accurately control a FET to produce a specific load current.

The software also asks for the termination voltage. When that voltage is reached the program will remove the load and print out the resultant battery capacity.

The photo at left shows the completed battery tester with a prototype of the Maximite.

We mounted two battery holders (AA and AAA) on the top of a UB5 jiffy box and built the circuit on a piece of strip prototype board inside the box. A short length of 26-way ribbon cable and a crimped IDC socket completed the device.

All the necessary power is supplied by the Maximite and when you want to test a battery it is simply a case of plugging the add-on into the Maximite and running the BATTERY.BAS program from the SD card.

The program will monitor the battery while it is discharging and at completion it will display the battery's capacity. You can then unplug the add-on and use the Maximite for something else.

You could add many other features to the program, for example the ability to draw a graph of the discharge curve or the ability to store the battery's performance in a data file on the SD card for later comparison when you test the battery again.

Ah, the possibilities !!

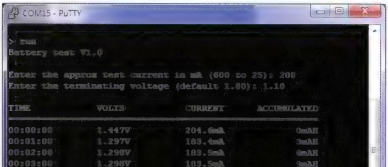


Fig.13: when you run the battery test software it will request the desired test current and the terminating voltage.

By JOHN CLARKE

12V 100W Inverter With Adjustable Output

Did you build the 12/24V 3-stage MPPT solar charge controller published in the February 2011 issue? Then you will probably want this companion 12V 100W inverter as well. It will power laptops and other devices which require a DC voltage between 15V & 35V.

SMALL SOLAR SYSTEMS are growing increasingly popular, whether it is for mains power, battery charging on boats, recreational vehicles and remote homesteads. But was well as needing solar panels to charge 12V or 24V batteries, you also need DC-DC converters to obtain supplies than cannot be run direct from batteries. Laptop computers are just one example.

We last published an adjustable DC-DC converter in the June 2003 issue of SILICON CHIP. This unit was powered by a 12V battery and could deliver an output voltage anywhere between 13.8V to 24V. The maximum output current that it could deliver was 2A at 16V, falling to 1.1A at 24V.

Unfortunately, this output current is often not sufficient to run a laptop computer or similar equipment. Many recent laptops require a supply voltage of about 19V and a current of 4A or more possibly more. So the June 2003 unit is simply not up to the job.

By contrast, this new design has a much higher output current capability and is suitable not only for powering most laptops from a 12V supply but for powering higher voltage equipment as well.

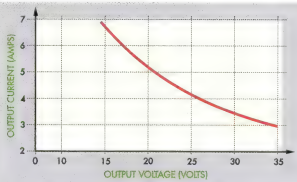
Fig.1 shows the output current capability of the new converter. The graph follows a nominal 100W power curve and as indicated, the circuit can supply just over 4A at 25V and 5A at 20V.

As well as its enhanced current capabilities, the new converter also boasts excellent voltage regulation at better than 99%. This means that the output voltage is maintained to within ±0.35V of its open-circuit voltage. However, some additional voltage drop can be expected in the leads running from the DC-DC Converter to the unit being powered.

Another excellent specification is the output ripple which is less than 200mV peak-to-peak at full power. However, once the input current exceeds 10A, the unit's output voltage begins to droop.

High efficiency

As with any such circuit, there are some power losses involved in converting from 12V to a higher output voltage. For this DC-DC Converter, the efficiency is well over 80% when supplying full power. This means that the unit only runs warm at full power, with any heat dissipated by the diecast box that houses it.



MAXIMUM OUTPUT CURRENT VS. OUTPUT VOLTAGE

Fig.1: this graph plots the output current capability of the 100W DC-DC Converter. It can supply just over 4A at 25V and 5A at 20V.

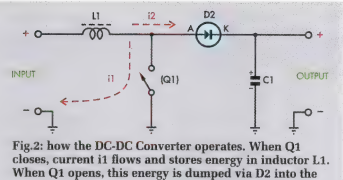


Fig.2: how the DC-DC Converter operates. When Q1 closes, current i1 flows and stores energy in inductor L1. When Q1 opens, this energy is dumped via D2 into the capacitor C2 (via current path i2).

Main Features

- Steps up a 12V DC input to between 15V and 35V DC
- Maximum input current 10A
- Efficient switchmode design
- Fuse & reverse polarity protection
- Power switch and indicator

This box measures 111 x 94 x 54mm and is fitted with a power switch and power-indicator LED at one end. Two cable glands are fitted at the opposite end and these clamp the figure-8 power input and output leads.

A cigarette lighter socket can be used to make the connection to a car's battery. Alternatively, the unit can be connected via 10A-rated wiring in a solar-powered system.

How it works

Fig.2 shows the basic operating principle of the DC-DC Converter. It comprises an inductor (L1), a switch (Q1), a diode (D2) and a capacitor (C1). When the switch is closed (ie, Q1 is on), current i1 flows through L1 (and the switch) and so energy is stored in the magnetic flux of the inductor. When switch Q1 subsequently opens, this stored energy is dumped via diode D2 to capacitor C1 (and the load). This is shown as current i2.

In our DC-DC Converter circuit, switch Q1 is an N-channel Mosfet. This Mosfet is controlled using an On Semiconductor (previously Motorola) MC34063 DC-DC Converter IC. This control device varies the Mosfet's duty cycle (ie, its on/off ratio) to maintain the desired output voltage.

This type of converter can only be used to step up (boost) the input voltage. If switch Q1 is left open, then current simply flows directly through L1 and D2. The resulting output voltage will be slightly lower than the input voltage due to the voltage across the inductor (due to its resistance) and the forward voltage of the diode. It is only when Q1 is rapidly switched on and off that the output voltage is increased above the input voltage.

Fig.3 shows the internal arrangement of the MC34063. Its components include a 1.25V reference, a comparator, an oscillator, an RS flipflop and output transistors QA and QB. The oscillator's frequency is set by a capacitor connected to pin 3. This oscillator drives the flipflop which in turn drives the output transistors to control the external Mosfet.

The comparator monitors a sample of the output voltage at pin 5. If the output voltage is low, the comparator's inverting input will be below the +1.25V reference. As a result, the comparator's output switches high and sets the RS flipflop. This in turn allows the output transistors to be toggled (via the RS flipflop) at the rate set by the oscillator.

The transistors are not held on permanently. Instead, the oscillator periodically resets the flipflop, either after a maximum period or if the peak inductor current, as sensed at pin 7, reaches a certain level.

On the other hand, if the output voltage is too high, the comparator's output goes low to keep the flipflop from setting. This holds transistors QA & QB off so that the output voltage falls.

Circuit details

Take a look now at Fig.4 for the circuit details. It's based on the MC34063 DC-DC Converter IC (IC1) but the internal transistors are not used to directly switch the supply current. Instead, they are used to drive power Mosfet Q1 which has a current rating of 118A at 100°C (the current rating is even higher at lower temperatures).

This rating is far more than is required for this circuit. What's more, the Mosfet's low 5.3mΩ "on resistance" with a 10V gate voltage ensures that it runs cool, even at 10A.

Power for the circuit is applied via

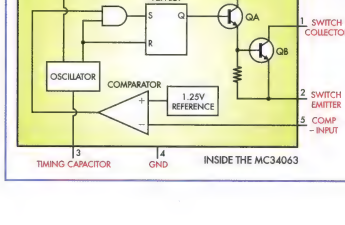
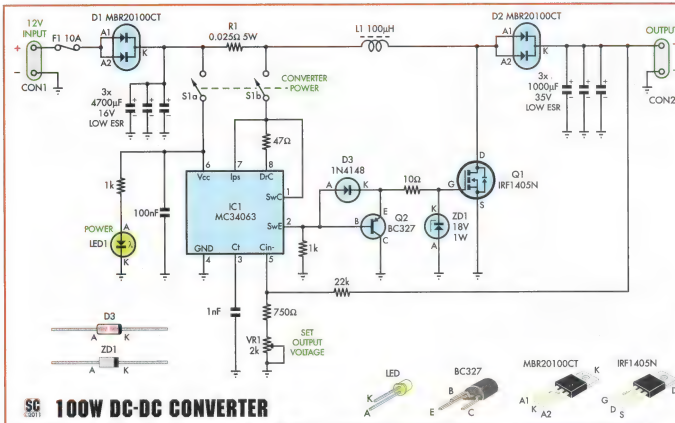


Fig.3: block diagram of the MC34063 DC-DC Converter IC. The oscillator drives the flipflop which in turn drives transistors QA & QB. The internal comparator holds the flipflop reset & shuts down the drive to QB & QB if the converter's output goes too high.



100W DC-DC CONVERTER

Fig.4: the circuit uses IC1 to drive the gate of Mosfet Q1 via diode D3, while transistor Q2 quickly discharges Q1's gate capacitance each time pin 2 of IC1 goes low. Voltage regulation is achieved by the feedback network connected to pin 5 of IC1, while current monitoring is achieved by monitoring the voltage across resistor R1.

fuse F1 and double diode D1. Fuse F1 protects against excessive current being drawn by the circuit (eg, if there is a short at the output), while D1 provides reverse polarity protection.

D1 is necessary although it does slightly reduce the efficiency of the circuit due to its forward voltage drop. However, without this diode a reverse polarity supply connection would cause current to flow in the reverse direction through the integral diode within Q1 and then through inductor L1, resistor R1 and the fuse. As a result, the fuse would blow.

This would not result in any damage but having the fuse blow due to a reverse supply connection is inconvenient. D1 solves that problem.

Note that D1 is shown as two diodes in parallel. These diodes are in the same package and are connected in parallel to increase the single diode continuous current rating from 10A to 20A.

A double diode has been specified because parallelling diodes in separate packages does not normally result in even current sharing between them. That's because the separate diodes are not matched for voltage drop and so the diode with the lowest voltage drop would carry most of the current. As a result, it will heat up more than the other diode and this then makes the situation worse. A diode's voltage drop decreases with increasing temperature and so the hotter diode will further increase its share of the load.

With a double diode, the two diodes are manufactured on the same silicon die and so have the same characteristics, including a matched forward voltage drop with current. The diodes also operate at the same temperature because they share the same package. This ensures consistent and almost equal current sharing over a wide temperature range.

Following D1, the supply is filtered using three parallel 4700µF low-ESR capacitors. These provide a reservoir of current for the following switchmode circuit which draws short high-current pulses.

Without the capacitors, the available current would drop markedly due to the inductance of the supply leads going to the 12V battery. Because of this lead inductance, the initial current available via the supply leads when Q1 turns on is low (it builds up over time). If not for the filter capacitors, the full current capability would never be reached due to the 30kHz switching rate of the MC34063 DC-DC Converter IC (IC1).

Power for IC1 is applied to pin 6 via switch S1a from the nominal 12V supply. A 100nF capacitor filters this supply rail, while LED1 provides "power on" indication. The 1kΩ series resistor limits the LED's current to around 10mA.

Note that the power switch (S1) switches power to the DC-DC Converter step-up circuitry only. When S1 is off, power is no longer applied to IC1 but there is still a current path from the 12V input to the output via fuse F1, D1, R1, L1 and D2. As a result, the output voltage sits approximately 1.2V below the input voltage (eg, if the battery voltage is 13.8V, the DC-DC Converter's output will be at 12.6V).

If the laptop requires an 18V supply, this will not be sufficient to charge the laptop's battery and so no current will be drawn from the converter. However, other loads could continue to draw

Parts List

1 PCB, code 11105111, 111 x 85mm
1 diecast box, 119 x 94 x 57mm
1 panel label, 79 x 103mm
1 powdered iron toroidal core, 42 x 22 x 17mm (Jaycar LO-1246 or equivalent) (L1)
4 2-way PC-mount screw terminals with 5.08mm pin spacing
2 M205 PC-mount fuse clips
1 M205 10A fast blow fuse (F1)
2 cable glands for 3-6.5mm diameter cable
1 DPDT toggle switch (S1) or 1 x SPST 15A toggle switch (eg, Jaycar SK-0976 – see text)
4 M3 x 15mm tapped Nylon spacers
4 M3 x 6m countersunk screws
4 M4 x 6mm machine screws
3 M3 x 10mm machine screws
3 M3 nuts
3 TO-220 insulating bushes
3 TO-220 silicone insulating washers
1 150mm length of medium-duty hookup wire
1 6.5m length of 1.25mm enamelled copper wire
1 25mm length of 0.7mm tinned copper wire
2 100mm cable ties
1 40mm length of 3mm heatshrink tubing
1 2kΩ horizontal trimpot

Semiconductors
1 MC34063AP DC-DC Converter (IC1)
1 IRF1405N 169A 55V N-channel Mosfet (Q1)
1 BC327 PNP transistor (Q2)
2 MBR20100CT 10A 100V double diodes (D1,D2)
1 1N4148 switching diode (D3)
1 18V 1W zener diode (ZD1)
1 3mm green LED (LED1)

Capacitors
3 4700µF 16V low-ESR electrolytic capacitors
3 1000µF 35V low-ESR electrolytic capacitors
1 100nF MKT polyester
1 1nF MKT polyester

Resistors (0.25W 1%)
1 22kΩ 1 47Ω
2 1kΩ 1 10Ω
1 750Ω
1 0.025Ω 5W (Welwyn OAR5-R025FI) (from **http://au.element14.com/** – Cat. 120-0377)

Miscellaneous
10A figure-8 wire, solder, etc

power. If this is not desirable, then an alternative arrangement using a 15A switch to fully disconnect power can be used, as described later. Of course, if power is derived via a car's cigarette lighter socket, this will be switched off when the ignition is switched off.

Current monitoring

Resistor R1 is included so that the current into the inductor can be monitored. IC1 does this by monitoring the voltage at pin 7. When pin 7 drops about 300mV below pin 6, IC1 ceases operation and current pulses cease flowing through L1. R1 has a value of 0.025Ω and so the peak current is restricted to 12A.

Mosfet Q1 is driven via IC1's transistor emitter output at pin 2 (SwE). Each time pin 2 goes high (ie, when the internal transistors turn on), it drives the gate of Mosfet Q1 via diode D3 and a 10Ω resistor. D3 is included to ensure that transistor Q2 is off during this time, by keeping its base 0.6V above its emitter.

Zener diode ZD1 protects Q1's gate from voltage spikes above 18V which could otherwise damage the Mosfet. The gate rise-time for 0-10V with a 12V supply is 500ns. When Q1's gate is high, Q1 turns on and current flows through Q1 and inductor L1 which then stores energy.

When the transistors within IC1 switch off, pin 2 is pulled to 0V via a 1kΩ resistor. Transistor Q2 now has its base connected to 0V and so this transistor switches on and quickly pulls Q1's gate voltage down to near 0V, thus switching the Mosfet off.

Q2 is necessary to ensure that Q1's gate capacitance quickly discharges (it would discharge too slowly through the 1kΩ pull-down resistor).

The gate fall time from 10V to 1V is about 500ns and a 1V gate voltage is sufficient to fully switch Q1 off (the gate fall time from 10V to 0V is 1µs).

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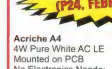
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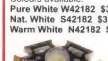
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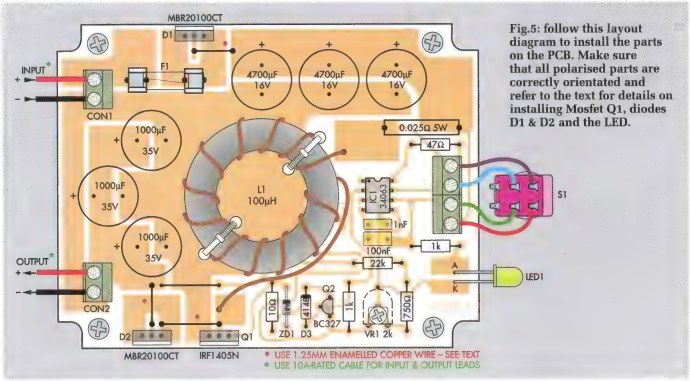


Fig.5: follow this layout diagram to install the parts on the PCB. Make sure that all polarised parts are correctly orientated and refer to the text for details on installing Mosfet Q1, diodes D1 & D2 and the LED.

With Q1 off, the energy stored in L1 is transferred to the output via double diode D2. This energy is then stored in three 1000µF low-ESR electrolytic capacitors. These reduce the ripple to less than 200mV peak-to-peak.

The resulting output voltage is sampled using a voltage divider consisting of a 22kΩ resistor, a series 750Ω resistor and a 2kΩ trimpot (VR1). This provides a proportion of the output voltage to the comparator input at pin 5 of IC1. In operation, IC1 adjusts its duty cycle to regulate the output voltage so that the voltage at pin 5 is 1.25V.

VR1 allows the output voltage to be adjusted between the recommended limits of 15V and 35V. Setting the trimpot to 64.8Ω gives a 35V output, while a 1.25kΩ setting gives a 15V output. A setting between these two values gives an intermediate voltage.

Construction

The DC-DC Converter circuit is built on a PCB coded 11105111 and measuring 111 x 85mm. This is mounted inside a diecast box measuring 119 x 94 x 57mm and has cut-outs to clear the pillars at each corner.

Fig.5 shows the assembly details for the PCB. The first job is to check that the indicated corner cut-outs have been made and that the board fits inside the case. If not, you will have to cut and file the corner cut-outs yourself.

That done, carefully inspect the board for defects, such as breaks in the copper tracks and shorts between tracks and pads. Check also that the hole sizes are correct by test fitting the larger parts (fuse clips, screw terminals, Mosfet Q1, diodes D1 & D2 and the trimpot). The screw terminal holes must all be 1.25mm in diameter, while 1.3mm holes are required for those wire links marked with an asterisk (*). Larger holes again are required for the fuse clips.

Once these checks are complete, start the assembly by the installing the wire links. **Note that you must use 1.25mm-diameter enamelled copper wire for the three links marked with an asterisk, to ensure sufficient current-carrying capacity.** The unmarked link can be run using 0.7mm tinned copper wire.

Bend each wire link so that it fits neatly in position and be sure to scrape away the enamel from the ends of the enamelled wire links before soldering them.

The resistors are next. Table 1 below shows the resistor colour codes but it's a good idea to also use a digital

Table 2: Capacitor Codes

Value	µF Value	IEC Code	EIA Code
100nF	0.1µF	100n	104
1nF	0.001µF	1n	102

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	22kΩ	red red orange brown	red red black red brown
❑	2	1kΩ	brown black red brown	brown black black brown brown
❑	1	750Ω	violet green brown brown	violet green black black brown
❑	1	47Ω	yellow violet black brown	yellow violet black gold brown
❑	1	10Ω	brown black black brown	brown black black gold brown

multimeter (DMM) to check each one before soldering it into circuit.

The 0.025Ω 5W resistor looks like a thin U-shaped strip of metal. It can go in after the other resistors have been installed, after which you can install diode D3 and zener diode ZD1. Be sure to orientate D3 and ZD1 as shown (D1 & D2 are installed later).

IC1 can either be mounted directly on the PCB or via a socket if you prefer. Install it now, again making sure that it's correctly orientated, then install the trimpot (VR1) and the capacitors. Check that electrolytic capacitors go in with the correct polarity.

Follow these with the screw terminal blocks. The 4-way terminal block is made using two 2-way blocks that are dovetailed together before mounting them on the PCB. They must all go in with their wire entry openings facing outwards.

The fuse clips can now be fitted. These must be mounted with their end stops towards the outside, otherwise you won't be able to install the fuse later on. The easiest way to ensure this is to fit the fuse into the clips before installing them on the PCB. Tack solder one leg of each clip, then remove the fuse and complete the soldering (this prevents the end caps from getting too hot and possibly melting the solder that secures the fuse wire to the caps).

Mosfet Q1 and diodes D1 & D2 are next on the list. These should all be mounted so that the hole centre in each tab is 21mm above the PCB.

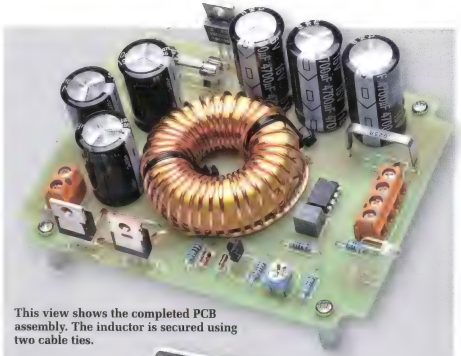
In practice, this means mounting each device with 9mm lead lengths. The easy way to do this is to cut a 9mm cardboard spacer, insert it between the leads and push the device down onto it before tack soldering one of the leads. The cardboard spacer can then be removed and the soldering completed.

LED1 must be mounted with 25mm lead lengths, so that the top of its lens is 30mm above the PCB. This can also be done using a cardboard spacer (25mm high). Take care with the orientation – the anode lead is the longer of the two.

Once the LED is in, it's bent over at 90° some 18mm above the PCB so that it's lens later goes into a hole in the side of the box.

Winding L1

Inductor L1 is wound with 34 turns of 1.25mm-diameter enamelled copper wire (ECW). Wind each turn tightly



This view shows the completed PCB assembly. The inductor is secured using two cable ties.

The two external cables and the switch leads must all be secured to the terminal blocks before the PCB is slid into the case.

Fig.6: Mosfet Q1 and double diodes D1 & D2 must each be isolated from the metal case using an insulating washer and insulating bush.

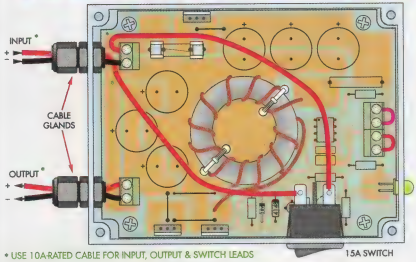


Fig.7: this diagram shows the alternative power switch arrangement.

In some cases, it may be preferable to switch the unit off completely, rather than just switching it to standby mode using switch S1. This can be done by wiring a 15A SPST switch in series with the incoming +12V rail and linking out the poles for switch S1 at the 4-way screw terminal block – see Fig.7.

The 15A power switch can be mounted on one side of the case. The incoming supply lead goes to one terminal while the other terminal is connected to the screw terminal block. **Be sure to use 10A rated leads for the switch wiring.**

A suitable 15A SPST switch is available from Jaycar, Cat. SK-0976.

around the toroid, keeping each turn alongside the previous turn. The wire ends are terminated on the PCB as shown. Note that one wire end passes around the outside of the core to insert into a hole adjacent to Q1 (see photo).

The entire toroid assembly is then secured in place using two cable ties that pass through the centre of the core and through holes in the PCB.

Drilling the case

With the PCB assembly now completed, it can be installed in the box. The first step is to temporarily place the board inside the base and mark out the four corner mounting holes. Drill these holes to 3mm, then countersink them from outside the case.

That done, the four M3 x 15mm Nylon stand-offs can be secured in position using M3 x 5mm countersink Nylon screws. The PCB is then again temporarily placed in position and the mounting holes for Mosfet Q1 and diodes D1 & D2 marked out. Drill these holes to 3mm, then **carefully remove any metal swarf using an oversize drill so that the mating areas are nice and smooth. This is necessary to prevent punch-though of the insulating washers later on.**

The next step is to drill the two holes for the cable glands at one end of the box (see photo). These cable glands each require a 12.5mm hole and should have their hole centres some 15mm down from the top of the base and about 20mm in from the top edge (so that they later line up with the 2-way screw terminal blocks). A small pilot drill should be used to start these holes, after which they can be enlarged to size using a tapered reamer.

Two holes are required at the other end of the box: (1) a 4.5mm hole to accept toggle switch S1; and (2) a 3mm hole for the LED. Position the switch hole about 10mm down from the top and in line with the centre of the 4-way screw terminal block. The hole for the LED is positioned 15mm down from the top. As before, remove any metal swarf from around these holes using an oversize drill.

Final assembly

Before mounting the PCB, it's necessary to connect the input and output leads to the 2-way terminal blocks. Similarly, the switch must be wired to the 4-way terminal block.

The input and output leads must be rated at 10A (or more). They are installed by first sliding them though the cable glands, then connecting them to their respective screw terminal connectors (watch the polarity).

Switch S1 is wired using 60mm lengths of hook-up wire and the solder connections covered in heatshrink tubing (this prevents the wires from breaking). The leads are then connected to the terminal block and a small cable tie used to further secure them.

Once the wiring is complete, the PCB can be slid into place and secured using four M3 x 6mm screws. It's then simply a matter of pushing LED1 through its hole in the case and securing the Mosfet Q1 and diodes D1 & D2 to the side of the case as shown in Fig.6. Note that the device tabs must each be electrically isolated from the case using a silicone washer and insulating bush.

Once the devices are in place, use a multimeter set to a high ohms range to confirm that the device tabs are indeed isolated from the case. If a low ohms reading is measured, check that relevant the silicone washer has not been punctured.

Front panel label

Once the assembly is complete, the front panel label can be downloaded in PDF format from the SILICON CHIP website. This can then be printed out, laminated and attached to the case lid using a smear of silicone sealant.

Testing

To test the unit, apply power to the input and check that the output voltage can be adjusted over the range from 15V to 35V DC using VR1. Note that if the output is unloaded, it will take a few seconds to drop down to the set voltage if VR1 is adjusted for a lower voltage.

Alternatively, if you have a 1kΩ 5W resistor, this can be placed across the output to hasten any changes as VR1 is adjusted. Assuming all is well, adjust VR1 to give the output voltage required for your equipment.

Finally, make sure that the output is connected to your equipment with the correct polarity. A suitable plug to make a power connection to your equipment can be obtained from an electronics parts supplier. SC

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Slow ADSL speeds? It could be your phone line polarity!

Phone Line Polarity Checker

Do you suspect your broadband speed (DSL) is slower than it should be? It could be as simple as incorrect polarity in your phone wall socket. Build this very cheap, very simple device to find out whether you need to change your wiring!

It might not seem that telephone line polarity is important, since the ring and voice signals sent over telephone lines are AC.

However the lines are actually biased to 48V DC (less when in use) and so the polarity can matter. The main problem with incorrect polarity is that some DSL (Digital Subscriber Line) modems and routers can perform poorly in this circumstance.

Since telephone wires are colour-coded, it should be possible to simply check that the sockets are wired correctly.

Unfortunately, there are multiple wiring colour schemes and they have changed over time. Believe it or not, the old colour scheme (from around 15 years ago) is identical to the current colour scheme except that the polarity of both lines is reversed!

This is why so many homes have this problem and yours may well be one of them.

Telephone line basics

The common telephone line is simply a copper pair, ie, two wires. As mentioned, there is usually a 48V DC bias across the pair which drops to around 8V when a telephone is "off-hook". The ring voltage (around 90V AC) and the audio signal voltage (also AC) are overlaid on this DC bias.

The DC power is "rectified" by each telephone on that line to run its own circuitry. Note, though, that this does not include cordless phones which usually use a plugpack, as their power requirements are far in excess of what the telephone line can deliver.

(As an aside, that is the reason it is important to keep a line-powered telephone in your home so you can still make and receive calls if the mains power goes out. Telephone exchanges can usually supply power from their backup batteries for up to some days, even if they are blacked out).

Usually, telephone lines are run with 4-core cable. This allows up to two lines on the one cable. The first line is on the inner pair (pins 2 and 3) and the second line, if present, is on the outer pair (pins 1 and 4).

Modern telephones use modular plugs, specifically RJ11 (6P2C, one line), RJ14 (6P4C, one or two lines) or RJ25 (6P6C, 1-3 lines). By the way, 6P4C stands for "six pins, four connectors". Incidentally, "RJ12" connectors are physically compatible – and commonly available – so that is what we have used in this project.

Because modern phones rectify the DC voltage from the telephone lines before regulating it and because the ring and voice signals are AC, for voice communications the polarity doesn't really matter.

For a number of reasons presumably due to the details of the DSL chipset or line interface implementation, certain ADSL modems work much better when the polarity is correct. Measurements comparing correct and incorrect polarity connections to the same modem show striking differences in performance.

In one case, with the incorrect polarity

Design by David Drane

(as the house was originally wired), the modem reported a very poor signal-to-noise ratio of 6dB and a line attenuation of 78dB, resulting in a downlink speed of just 800kbit/s.

Correcting the polarity of the line resulted in the download speed going up to the full 1500kbit/s (limited at the exchange), with the signal-to-noise ratio improving to 34dB and the attenuation down to 45dB.

This is just one example; this solution has been successfully tested many times in the field.

The speed, signal-to-noise ratio and attenuation figures can be read off most modem/routers by accessing their web interface (see the documentation provided with your modem/router for more details).

If your speed is well below what it should be, it's possible that it is due to swapped line polarity. Obviously there can be many other reasons but this simple check at least makes sure your line is not the culprit!

Of course, you can check the line polarity using a multimeter but it is a very fiddly process as it's hard to make contact with the modular connector pins using standard probes.

It's also hard to figure out which polarity is correct. This project solves that entirely. Simply plug this unit in, using a standard telephone cable and the LEDs immediately indicate the polarity of the one or two telephone lines.

How it works

The circuit, shown in Fig.1, is very simple. The polarity is correct if pin 2 is at a positive voltage relative to pin 5 and pin 4 is at a positive voltage relative to pin 3.

To check this, for each line we connect two LEDs of different colours (green and red) in inverse parallel, ie, anode to cathode. They are then connected to the lines, with a 12kΩ current-limiting resistor, so that the green LED will be forward biased (and the red one reverse-biased) if the line polarity is correct and vice versa if it is swapped. This results in the green LED for each line lighting if its polarity is correct and the red if it isn't.

The 12kΩ resistor value is chosen to give a reasonable

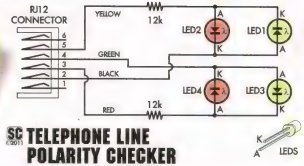


Fig.1: the circuit diagram – with just two resistors and four LEDs, it could hardly be simpler.

amount of current under typical conditions.

With all the telephones on that line on-hook, we expect 48V DC and so around 4mA flows through each forward-biased LED, lighting it up quite nicely.

If the LED lights dimly, this either means that one or more handset is off the hook or else that the line voltage is low (usually due to a fault).

Building it

Before building the board, decide how you are going to house it. We mounted ours in a small, translucent UB5 jiffy box. In this case, the LEDs do not need to protrude through holes in the case as they can be seen through the lid.

If you use an opaque UB5 jiffy box you will need to mount the LEDs higher, so they can protrude through appropriately positioned holes. Other arrangements are possible but we will leave the details up to you.

Check the copper side of the PCB for defects and repair if necessary. If you are going to mount the board in a jiffy box and the corner cut-outs have not already been made, cut and file the board to the shape shown so that it will clear the pillars in the box.

Refer now to Fig.2, the overlay diagram.

Solder the two resistors in place and trim the leads. The resistors should have a colour code of brown black orange brown (4-band code) or brown black black red brown (5-band code).

Then install the modular connector. Position its pins over their mounting holes and then push it down fully onto the board, so that the plastic posts lock. If they will not fit then you may need to slightly enlarge the holes that they go in. Once it is flush with the board, solder the six pins.

Now install the LEDs. Be careful to ensure that the anodes (longer leads) go into the holes marked with "A" on the overlay diagram. If you are using a translucent jiffy box, the

Parts list – Phone Line Polarity Checker

1 PC board, coded 12105111, 56.5 x 48.5mm
1 6P6C RJ-12 PCB-mount modular socket (Jaycar PS1474, Altronics P1425)
2 red 3mm LEDs (LED2, LED4)
2 green 3mm LEDs (LED1, LED3)
1 UB5 jiffy box (preferably clear/translucent)
1 spacer, 21mm long (see text)
1 label (optional but recommended)
2 12kΩ 0.25W resistors (any tolerance OK)

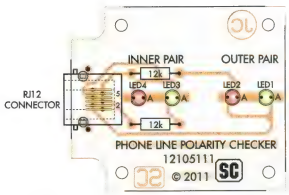
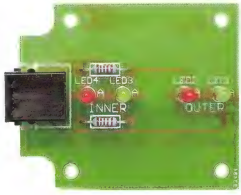


Fig.2 (left) same-size component overlay, along with a matching photo at right. With so few components you could hardly go wrong, unless you get the LEDs back to front or around the wrong way, or bend a pin on the RJ12 connector, or make a dry joint, or . . .



top of each LED should be flush with the top of the modular connector. Otherwise, the flat section at the base of each LED lens should be flush with the top of that connector.

Once you have trimmed the leads, you can still check that the LED orientation is correct by looking for the flat side of the lens. In each case, this should face away from the "A" on the overlay diagram as it indicates the cathode side.

Housing it

If you are using a UB5 jiffy box, the completed PCB should snap into the indentations moulded into the inner columns of the case. You will then need to cut a notch in the end for the modular socket to protrude through and this is most easily done using a nibbling tool. Make the hole slightly too small then use a needle file to finish it off.

Because the board is shorter than the box, you will need to prevent it from moving when a modular plug is inserted.

We achieved this by making a spacer which fits exactly between the end of the board and the box, then used hot melt glue to hold it in place. The spacer can be made from practically any rigid material – we cut a small length off some surplus plastic DIP tubing which cannot be seen once the translucent lid is in place. Our spacer measured 21mm long.

You could also simply glue the board into the box although this may eventually fail due to the stress from repeated connector insertions and removals.

If your box is opaque then you will need to drill four 3mm holes in the lid to accommodate the LEDs as it is screwed in place.

A photocopy or print-out of the PCB pattern can be used as a drilling template if carefully positioned on the lid to match where the board is mounted.

It's probably a good idea to glue a label to the lid so that you can remember which LEDs mean what. You can use a photocopy of Fig.3 or print it out from the SILICON CHIP website. These days, we use our trusty hot laminator to make our labels virtually indestructible; certainly impervious to fingerprints and junk-box dirt.

Of course, you'll need to punch some holes through the label (even if using a translucent jiffy box) so the LEDs can be seen glowing underneath.

We recently purchased a set of ten leather punches on eBay for the princely sum of $5.00 – and they're perfect for punching holes in laminated paper labels.

Here you can see the cutout for the RJ-12 socket (front of pic) along with the scrap of plastic (actually a piece of DIP IC rail) we glued into the bottom of the case to stop the PC board moving within the case.

Using it

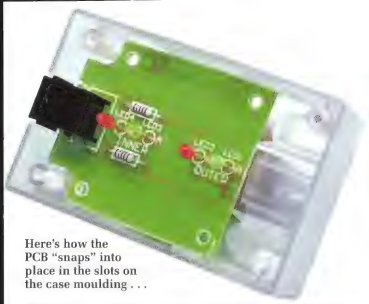
It doesn't get much easier than this. Simply plug the telephone line in question into the unit and observe the colour of the LEDs.

If possible, use the same cable used to connect the equipment to the line in case the cable itself is incorrect (unlikely but not impossible).

One of the "inner pair" LEDs should light and if there is a second line present, one of the "outer pair" LEDs will light too. Green means the polarity is correct and red means that it is swapped.

If the green and red LEDs in a pair are rapidly flickering,

Fig.3: as well as being a label in its own right, you can photocopy (or download) this front panel label to use as a drilling template if you aren't using a translucent case. You'll also need to punch out the four circles so you can see the LEDs, regardless of which type of case you use.



Here's how the PCB "snaps" into place in the slots on the case moulding . . .

And here's how it looks complete with the front panel glued on, with cutouts so you can see the LEDs underneath.

plug the phone back in because that indicates someone is ringing you!

If the LEDs are dim, the line may be in use. If it is not then the line is probably faulty, resulting in a low line voltage.

You can confirm by measuring with a multimeter; if the voltage is below 40VDC then you have a line problem. This is often caused by water getting into the junction pit which is generally outside the premises.

In some rare cases, it's possible that the line voltage is excessively high and this will be indicated by the LEDs being brighter than usual.

The 12kΩ current-limiting resistors are high enough that even if the line voltage is double what it should be, no damage will occur.

When the polarity is wrong, it's simply a matter of re-wiring the connector to swap the offending pair or pairs.

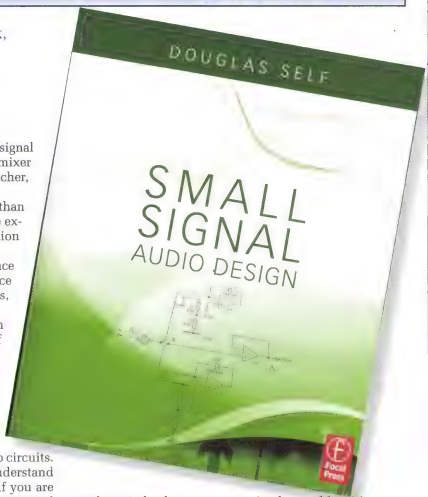
Modular wall sockets usually use "punchdown" type termination at the rear and in this case, it's simply a matter of pulling the wires out of their slots, rearranging them to be correct and then using a punchdown tool to push them back in. This tool strips the insulation and "punches" the wire into the socket to make the electrical connection.

(Dare we say it? We also bought a brand new punchdown tool on eBay for $2.00 including postage!)

If your socket has a different termination style (eg, screw terminals), the principle is the same. Swap the offending pair(s) and then check that the polarity is correct.

It should be plain sailing after that. SC

Small Signal Audio Design Handbook, by Douglas Self. 1st edition, 2010.
558 pages, soft covers, 190 x 235mm.
ISBN 978 0 240 52177 0.
Price $103.95



If you are going to design any analog audio signal processing circuitry, such as a preamplifier, mixer or even just a volume control or input switcher, read this book first.

After doing so, you will design better circuits than you could have thought possible. It doesn't take expensive parts to design circuits with low distortion and noise.

The Author, Douglas Self, is an audio performance guru. Few people have his extensive experience designing audio gear (such as power amplifiers, preamplifiers and mixers).

He combines the resulting experience with a thirst for rigorous analysis, with the aim of achieving impeccable performance.

We reviewed another book by Douglas Self, the Audio Power Amplifier Handbook (Fifth Edition), in the March 2010 issue of SILICON CHIP. The two books can be viewed as companion volumes and together they endow the reader with a profound understanding of the performance determining factors in analog audio circuits.

You do not need an engineering degree to understand Self's writing but you will find it much easier if you are familiar with basic operation of op amps, transistors and passive components. He assumes that you can analyse basic circuits but regardless, does a good job of explaining his design techniques and why they are superior to the alternatives.

The chapters are logically arranged and the prose is easy to read. Both text and diagrams are large and clear. You can read the book one chapter (or a few pages) at a time but it also makes a good reference volume. There are plenty of circuits within it that will come in handy in future.

Rigorous analysis

Self's technique for improving circuits is quite straightforward. First, he takes the basic circuit and measures its performance – Audio Precision frequency response, total harmonic distortion and other graphs are heavily featured.

If performance of a proposed circuit is found wanting, he then breaks it down into smaller pieces and uses basic circuit theory to figure out where the problems lie. He then presents the revised circuit and a performance comparison to the original.

If the performance is still not up to scratch, this process is repeated as many times as necessary. Often the final circuit isn't much more complicated than the original but works much better.

He tends to shy away from exotic parts or complex designs as they increase the size and cost of the finished product. As he demonstrates quite thoroughly, it's more about how you arrange the circuit than what's in it.

Once you understand his approach, you can use this technique yourself. By the end of the book you will understand the sources of noise and distortion (and other non-ideal properties) well enough to figure out for yourself how to avoid them in your own designs.

The book features plenty of circuit diagrams, many of which can be built right away. It also contains many distortion graph plots, often comparing the performance of several different versions of a circuit, along with tables showing noise performance against source impedance and so on.

No circuit is too simple to be improved using Self's method. Take the humble voltage divider; a signal can be attenuated by 6dB (reduced in voltage by half) with just two equal value resistors.

In isolation, though, this is a lousy way to do it since it either loads the source excessively (with low value resistors) or has poor noise performance (with high value resistors). He shows how the addition of a buffer and carefully chosen resistor values can produce a much better attenuator.

Questions answered

Throughout the book, a number of questions are answered which have been the source of discussion in the

SILICON CHIP offices quite recently. Questions such as: Can electrolytic capacitors be used for signal coupling without introducing distortion? Can polarised electrolytics be operated reliably with very low bias voltages? Is there an advantage in using polypropylene capacitors over polyester types? He answers all of these questions, and more.

Some of the answers provided in the book are to questions we had not thought to ask – but in retrospect, we probably should have.

For instance, thick film resistors have significant nonlinearities which can introduce distortion. As he puts it, they don't really "obey Ohm's law". This is an important consideration for designing audio circuits using surface-mount components.

The book contains some pleasant surprises in the form of simple circuits with surprisingly good performance, some of which are quite unique.

Some of the circuits presented are improved versions of those which are so common that in the past, we have not batted an eyelid before using them. Often the performance can be improved without increasing the component cost at all.

One of the themes throughout the book is that of low impedance design and minimising noise through low source impedances.

Have you ever wondered why high value DC bias resistors do not compromise noise performance but high value feedback resistors can? Once you understand Johnson noise, voltage/current noise, source impedances and related phenomena, it all makes sense.

Another surprising revelation: most engineers and technicians know that balanced audio signals result in less hum and interference but did you realise that a typical balanced input circuit is a lot noisier than an average unbalanced input?

As usual the Author presents various methods for solving this dilemma but it turns out that to get very good noise performance with a balanced input is not easy.

Highlights

In the chapter on Discrete Transistor Circuitry, Self presents multiple circuits which use a handful of bipolar transistors to create buffers, inverters and gain stages with surprisingly good performance, given their simplicity. One benefit of these circuits is that they will operate with supply voltages well in excess of a typical op amp.

In the chapter on Op Amps and Their Properties, he shows how common and cheap op amps can be used to very good effect. In fact for the most part, the more expensive and exotic op amps are shown to have worse performance than older designs like the NE5532 and LM833.

Other useful circuits are presented such as ultra-low-noise microphone preamplifiers with variable gain, active volume controls, signal swing limiter circuits and more.

Douglas Self reveals in the book that he is experienced at designing mixers (including at least one award-winning design) and this clearly shows. Only a relatively small portion of the book is dedicated to mixer circuits and configurations but there is a lot of good information in there and he gives several simple but very effective techniques for maximising performance, yet again.

Criticisms

Obviously, we really like this book. There are however a few sections that could be better. For example there are two chapters that deal with designing circuits to interface with turntables (ie, moving magnet and moving coil cartridges). While they contain interesting information and circuits, it could be argued that the application for which they are designed is essentially obsolete.

And while the circuit descriptions are mostly very thorough, in a few places Self presents a circuit and seems to assume that the reader can figure out how it works. This is mainly evident with the circuits which combine discrete transistors with an op amp for improved noise performance. It is possible to use basic theory to analyse the circuits and understand them but a more detailed explanation would be nice.

Summary

If (like several SILICON CHIP staff members) you are an audio enthusiast, this book will give you inspiration and ideas.

It will also help you become a better designer with, among other things, a better understanding of component peculiarities and how to work with them (and in some cases, around them).

It is also a pleasant read for the technically inclined and can be leafed through at leisure. Self even has a sense of humour and the book is good for the occasional chuckle.

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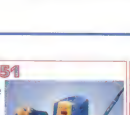

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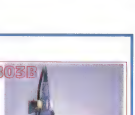

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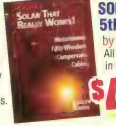

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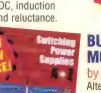

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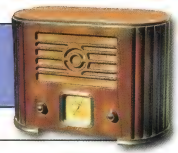
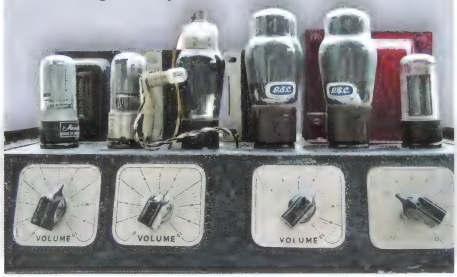


By RODNEY CHAMPNESS, VK3UG

How NOT to build vintage gear . . . plus cleaning away the gunk

There are lots of things to consider when building or restoring vintage radios, including function, performance, reliability, ease of service and safety. However, there are a few things that you must not do.



A front view of the old PA amplifier with the cover removed. Note the three volume control labels, one of which is actually for a 4-position switch! The chassis can not be placed upside down with the valves in place, which makes servicing difficult.

RECENTLY, I TOOK A LOOK at an old 15W public address (PA) amplifier that I had acquired some years ago, my aim being to restore it to working order. The unit had been stored in my workshop for a number of years and I hadn't really looked at it closely until now. From the outside, it appeared to be a commercial unit but as work progressed, it soon became evident that this PA amplifier was actually home-made.

In fact, during the 1940s and early 1950s, chassis kits complete with top and bottom covers were produced so that home constructors could make their own PA amplifiers. Commercial PA amplifiers were not particularly common at that time and "Radio & Hobbies" magazine described many PA amplifiers over the years. This particular amplifier (not an R&H design) had been built into one such chassis kit, hence my initial impression that it was a commercial unit.

Anyway, I placed it on the bench, dusted it down and ran a damp rag over the outside of the case to clean it up. I then removed the top cover which protects the valves, the power transformer, two filter chokes and the audio output transformer. This was also dusted out and I then ran a damp cloth over the chassis and the transformers.

Next, I took the six valves out of their sockets and carefully cleaned them with warm, soapy water. With octal valves, I hold them upside down and rub the soapy water onto the glass envelope to clean the dust and other muck off the envelope. However, I take care to avoid rubbing the labels as they are all too easily washed off along with the muck.

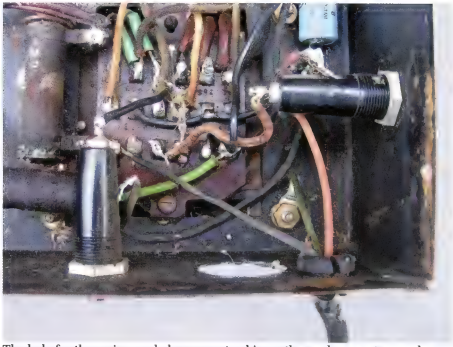
Once the envelopes were clean, I wiped the valve bases with a slightly soapy rag, taking care to ensure no moisture could get down inside the bases. Finally, I wiped the glass envelopes with a clean damp rag and left the valves lying on their sides to dry.

By this stage, the top of the chassis was looking reasonable although I wasn't particularly thrilled with the previous owner's paint job. First, the paint had not been applied evenly to the chassis, probably because spray paint cans weren't on the market at that time. Even worse, the chassis hadn't been painted at all between the HT chokes and the power transformer, indicating that painting took place with these parts bolted in place.

But what was really strange was that the power transformer had been painted red. It really looks out of place but even so, I still thought that this was a commercially-built piece of equipment with just some rather ordinary paintwork.

The under chassis shocks

It was now time to work on the under-chassis area. Leaving the valves out (so that they couldn't be damaged),



The hole for the mains cord clamp was too big, so the cord was not securely clamped. As a result, the cord has pulled back through it, leaving the internal mains wires under tension (especially the Neutral lead).

This photo clearly shows some of the dodgy under-chassis wiring. Many of the smaller components have long leads and are simply soldered together in mid-air. This allows the leads to flex and short against other parts.

I turned the chassis upside down and removed the metal sheet shielding the underside. This amplifier weighs a hefty 14kg, so the valves would have almost certainly been damaged if they had been installed (some of them are higher than the transformers and chokes).

With the shield removed, I took a look inside and was stunned at the poor quality of the work. The wiring was so bad that there was no doubt this was a home-made amplifier. Even the worst manufacturers would not have taken so many stupid short cuts and I was unimpressed to say the least

It was so bad that there was nothing for it but to abandon the restoration. At the very least, it would require a complete strip down and rebuild and it

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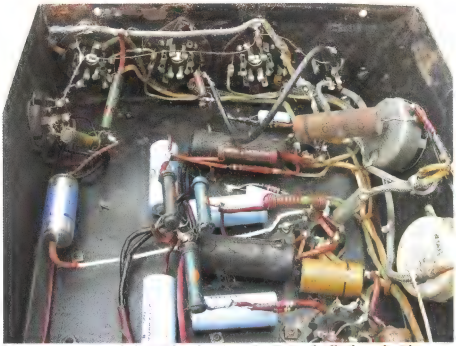


Another view of the dodgy under-chassis wiring. It's so badly done that there was no point in restoring the old PA amplifier to working order.

just wasn't worth the effort. However, since it was so badly laid out and built, I decided that it would make a good article on how NOT to build or wire such equipment, or any vintage radio gear for that matter.

So what is so terribly wrong that I was forced to abandon the restoration? First, as mentioned, the valves are higher than the transformers and chokes, so the chassis cannot be upended without damaging these valves. I have another PA amplifier that I can easily tip upside-down with no likelihood of damage to the valves or any other components (see accompanying photo). However, that's a relatively minor point and I could live with this inadequacy.

It's the under-chassis wiring that's really atrocious. To begin with, there are no tagstrips on which to mount any of the small components and this is obvious from the photographs. Instead, the valve socket pins and some of the larger chassis-mounted parts formed many of the tie points for the smaller components, with the rest of the components then strung together in mid-air!

In some rare instances, stringing components together in mid-air without tag strips or mounting boards may be acceptable. However, when it is systematic as in this particular chassis, it is to be condemned. The leads were twisted together and then soldered and this makes the parts quite difficult to remove if they become faulty. What's more, in some circumstances, the leads and components could flex far enough for short circuits to occur.

Many years ago, I had to service a home-made high-frequency (HF) transmitter that was wired in a similar manner to this amplifier. Unfortunately, because of the types of components used in a transmitter, there were not many chassis-mount parts that could be used as tie points. In the end, I told the owner that I couldn't service it as it was and suggested that I rebuild it – which I did.

I remember that in order to remove the old, tangled web of floating wiring, I first disconnected the wires going to the valve socket pins and to the few large fixed parts. I was then able to lift the entire mess out as one complete tangled clump of wires and small components. It all reminded me very much of an inner spring mattress!

Strange microphone sockets

Getting back to the amplifier in question, the microphone sockets were fitted to one end of the chassis. However, these were actually octal valve sockets which are not really suitable for microphone use. The other end of the chassis carries a fuseholder, while the back edge carries another of these fuseholders, along with the mains cord entry.

The mains cord attachment is definitely unsafe. Admittedly, the previous owner had used a cord-grip cable clamp but its mounting hole was too large and it did not grip the cord with sufficient tension. As a result, the mains cord has pulled through this clamp, leaving the mains wires inside the chassis under a great deal of tension (see photo). In fact, the wires are under so much tension it's a wonder the connections haven't failed.

Labels & valves

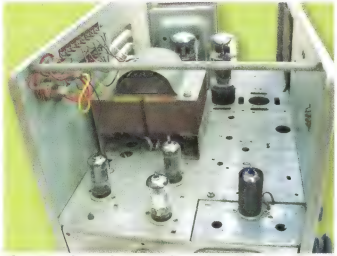
The front panel controls have metallic labels that could be bought from the radio retailers of the era. These nickel-plated labels look OK but one of the three labelled "volume" controls is actually a 4-position Oak switch! Your guess is as good as mine as to what this control actually does.

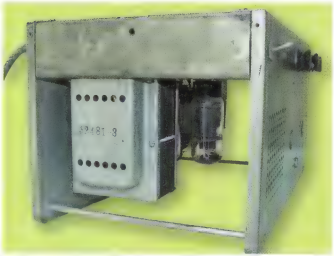
The valve line-up uses a 6SJ7 preamplifier followed by another 6SJ7 which functions as an amplifier. This then feeds a 6U7G phase-splitter which in turn drives push-pull KT61s in the output stage. A 5Y3GT as used as the rectifier. The grid lead of the 6U7G is not shielded and I suspect the amplifier may have had some hum in the audio as a result.

In short, if an item is being homebuilt, it's important to take the time to properly lay out the chassis and include proper tie points (eg, tagstrips). It's also important to keep inputs and outputs separated as much as possible. Valve shields will be necessary in some cases to ensure stability and to minimise hum, while shielded cables are necessary for low level audio leads and (often) radio frequency (RF) leads.

You also need to take into account the number of parts to be fitted and their size, so that everything fits in the available space. And you need to ensure that capacitors and tuned circuits are kept well away from heat-producing sources such as valves and high-wattage components.

It's not unusual for the heat from valves to damage cabinet tops, even in commercial equipment. This can occur even when asbestos or some other material has been used to shield the cabinet. Asbestos sheets were sometimes fitted next to the output and rectifier valves in some early AWA radios. If you come across this material, remember that asbestos is a carcinogen and needs to be treated with extreme care.





These two photos show one of my other old PA amplifiers. Unlike the original unit, this PA amplifier can be tipped upside down for servicing without damaging the valves, the chassis itself providing the necessary protection.

Unfortunately, chassis layout is often a compromise. Achieving the best layout in terms of electronic stability and performance sometimes means that terminals, volume controls, on-off switches and various plugs and sockets could finish up in inconvenient locations. These problems can often be overcome by using extension shafts on controls or by placing the controls in more practical locations and using shielding and/or shielded cable.

This PA amplifier is a great example of how not to do any of these things, except that there's nothing wrong with the locations of the transformers and chokes!

Cleaning chassis & parts

Now let's take a brief look at some of the techniques used to clean old radio chassis. Unfortunately, some of the methods used over the years have proved to be rather destructive, both to the chassis and to individual components. In addition, some chemical cleaners can be hazardous to your health if not used correctly.

Several years ago, a friend who is an industrial chemist put together a list of safe, non-destructive cleaning techniques for vintage radios. With his permission, I have rewritten the information in a format suitable for this column.

Both chemical and mechanical methods can be used to remove the accumulated muck and corrosion from our radios. However, in this short article, I'm only going to concentrate on the mechanical methods.

It's incredible what sort of material, both organic and inorganic, can be found stuck to old radios and to their components. Getting the gunk and corrosion off is often only partially successful but if cleaning is pushed too far, it can be quite destructive. Some component materials react with the gunk on them while in other cases, the contaminant can soak in and be absorbed.

Clearly, if you can identify what the contaminant is, then you have a better chance of correctly removing it. However, it may sometimes be better not to remove it completely in order to avoid damage. The same applies to the chassis – should it be thoroughly cleaned and repainted or just superficially cleaned and left in its weathered state?

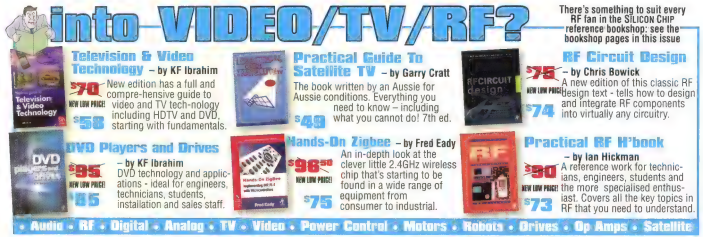
That's a decision that must be made by the restorer on a case-by-case basis.

Mechanical cleaning methods

OK, so let's take a look at the main mechanical cleaning methods:

Brushes: using a brush is one of the best methods when it comes to removing dust from delicate objects. For radio parts and chassis, you will need a set of brushes with soft bristles, eg, paint brushes. You can also use small specialised brushes from art suppliers and hobby shops.

Don't use stainless steel wire brushes to clean radio chassis or other parts.



The power transformer had been painted red but there was no paint on the chassis between the HT chokes and the power transformer.

They can really do serious damage (and yes, I've seen the results of this type of heavy-handed treatment).

Vacuum cleaners: vacuum cleaners can be used in conjunction with brushes, either as dust extractors or blowers. However, be careful when using a vacuum cleaner around a radio chassis. They can easily destroy the cone of a loudspeaker and possibly damage other parts as well.

Don't use a vacuum cleaner in conjunction with volatile solvents, as sparking at the commutator in the motor could ignite the fumes.

Blowers: a speed-controlled air-blower is the preferred device for blowing dust and light muck out of equipment. Wherever possible, this should be done outside the workshop, otherwise the dust will settle on other equipment.

Using air-compressors to blow out vintage radio gear is not generally recommended. A high air velocity can actually blow some parts to pieces or worse, blow particles at high-speed into your eyes if you are one of those people who neglects to wear eye protection. In addition, the air from most compressors will contain water and oil if not heavily filtered.

That said, air-compressors do have their uses, especially if fitted with a small hand-held nozzle with an adjustable trigger that can regulate the air flow.

Damp cloth & water: it's amazing what you can shift using just a damp cloth and water (including valve numbers and station markings on glass dials if you are not careful). The new generation of "micro-fibre" cloths can pick up an amazing amount of dust without scratching but as always, there are limits.

Abrasive techniques

Knives, chisels, screwdrivers and various abrasives (eg, steel wool) all have their place when it comes to cleaning up old radios. Of course, serious butchery can be done with these but sometimes their use is necessary to get results. It's just a matter of applying common sense and a deft touch.

Steel wool, for example, can be used as a fine abrasive on timber and other hard surfaces, usually without scratching. It can even clean muck off valve glass envelopes but again, take care to avoid type numbers.

Sandpaper, emery paper and wet and dry paper of various grades are suitable for cleaning the chassis and various other hardware items. Start with the coarser grades and then progress to the fine grades to remove any scratch marks. Kitchen scourer pads are good for cleaning chassis too, particularly when soaked in kerosene.

Car polish can also be used as a mild abrasive, as can toothpaste. Alternatively, you can mix baking soda (sodium bicarbonate) in water to make a mildly abrasive paste.

Baking soda is also found in some dry powder fire extinguishers and was used in the old "soda acid" type water extinguishers. It is often used to neutralise acid on lead-acid battery leads and terminals and as a mould inhibitor in refrigerators.

Devices which contain lots of brass and formaldehyde plastic often exhibit the formation of verdigris within the device. A sachet of baking soda may prove useful in preventing this if it can be fitted inside the device. Note that the sachet must be permeable, eg, made of cloth.

Screwdrivers, knives and chisels can be run along surfaces to lift or loosen some of the muck. This must be done with care to avoid scratches but if the muck is really caked on, this may sometimes be unavoidable.

In some cases, it may be necessary to do some restorative work after the surface has been thoroughly cleaned. Rust converters and similar chemicals can be useful here, as can fillers such as car bog compounds.

In summary, provided you're careful, the chassis and other major parts can generally be restored to good condition. Sometimes, you will need to combine mechanical cleaning methods with chemical cleaners but don't overdo it otherwise you could do irreparable damage. **SC**

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6V operation for 12V DC-DC converter

Is it possible to adapt the 12V DC-DC Converter (SILICON CHIP, June 2003) to 6V operation. I guess that rules out using the standard Mosfet but could it work with a logic Mosfet or a Darlington? (D. S., Narrabeen, NSW).

● Mosfet Q1 would need to be a logic-level Mosfet and the available output power would be less than half that quoted for the 12V version. So it would be a nominal 15W DC-DC converter instead of 30W. Inductor L1 would need about 45 turns instead of 33 turns. Zener diode ZD1 should be 8.2V and the 1000µF low-ESR capacitors could be rated at 16V instead of 25V.

Heatsink insulators for the 12V amplifier

With regard to the 12V Compact Stereo Amplifier (SILICON CHIP, May 2010), neither Jaycar nor Altronics have TO-218 insulating washers. Would it be OK to mount the IC direct to the heatsink and insulate the heatsink from the case? (P. C., via email).

● You could certainly do that. The TDA7377 tab is held at PCB ground potential so there will not be much radiation from the heatsink. The PCB ground is different from chassis ground though, which is why they need to be insulated from each other.

Keep in mind that the TO-3P outline is virtually the same size as TO-218 so those washers will work too. Jaycar sell TO-3P insulating washers made from silicone rubber (HP-1174) but they do not conduct heat as well as mica so the amplifier may run into thermal limiting sooner.

Altronics sell mica TO-3P insulator kits (H-7120).

Substitute transistors for Studio 350

I have the Studio 350 Amplifier (SILICON CHIP, January & February 2004) and need to replace the 2SA1084 PNP low-noise transistors. I can't find them anywhere and was wondering what I can replace them with? (C. B., via email).

● You can use 2SA970s (used in the Ultra-LD power amplifier) if you can't get 2SA1084s. They should be available from Altronics or **www.futurlec.com** Failing that, you could use BC556s although their noise figure is not quite as low.

No need to modify code for Fast Charger

With reference to John Clarke's Fast Charger for NiMH batteries (SILICON CHIP, September 2007). is there some way to change the PIC code so that after the charge cycle is complete, the charger will pulse the battery while it is still connected to keep it charged, eg, switch on the Mosfet for say five seconds every 30 seconds while still monitoring the thermal limits which will switch off the Mosfet if exceeded? (G. W., via email).

● The NiMH fast charger includes trickle (or float) charging to ensure the battery is maintained fully charged. This trickle charge is enable by installing jumper link LK3. Details for setting up the trickle current is detailed in the "Trickle" section of the article.

Current drain of Digital Fuel Mixture Display

I am looking at building the Digital Fuel Mixture Display (SILICON CHIP, September & October 2000). I wish to put it on a KTM dirt drag bike 700cc single cylinder 4-stroke which runs on VP C10, a 100 octane unleaded fuel. With this fuel it seems to be hard to read as to whether you are rich or lean!

I would have to purchase the recommended Bosch oxygen sensor and acquire some shielded cable to run from there up to the unit. My question is what current requirements are there to drive this system, as I only have a 12V 1.3Ah battery? (B. L., via email).

● The Fuel Mixture Display draws

How To Prevent Momentary Loss Of DVD Playback In A Car

I have two headrest DVD players in the car. The kids get in and start up their DVDs, then I get in and start the car. As the DVDs are connected to the accessories circuit, the power drops out and causes a chorus of "Daaaaddd!!!!!" from the rear of the car. the same happens when we are getting petrol.

I want a device that can keep the power flowing for 10 or so seconds while the car starts.

Can someone come up with a solution? I have not measured the current drain at this point; maybe a big capacitor or a small 12V rechargeable battery that recharges while the car is turned on and a time based cut-off to stop it draining.

Looking forward to a creative (low cost solution). (P. K., via email).

● In all likelihood you would need a big capacitor bank, fed by a power diode. Alternatively, you may need to run the DVDs from a separate battery fed by a power diode.

As a first attempt, we would suggest two 10,000µF 25V capacitors in parallel fed by a Schottky diode with a rating of 10A or more.

On the other hand, you could just tell the kids to belt up and look out the window – after all, when we were kids our Dad didn't even have a radio in the car, etc, etc.

And if you do solve the problem of the temporary halt in entertainment, will the kids think you are really brilliant?

Transformers For The Class-A Monoblocks

I have purchased the left and right modules of the 20W Class-A amplifier and the associated heatsinks from Altronics. I plan to mount them in separate enclosures as "Monoblocks" and I also plan build a separate power supply for each module, eg, two transformers, two bridge rectifiers, two specified power supply kits, etc.

I can buy the two power supply kits from Altronics but the specified 16V+16V 160VA transformer is not a stock item. They stock a 15V+15V 160VA and an 18V+18V 160VA unit. Which one would best suit the 20W Class-A module?

Also, I'm thinking of mounting the power supplies in separate enclosures as well but I am unsure which is the best way to go about it. I have been researching external power supplies for amplifiers and there's so many different "theories" that I'm a bit confused.

Some say keep the bridge and capacitors alongside the power amplifier module and just keep the transformer on its own; others say keep the transformer, bridge and capacitors on their own and some say to install the capacitor banks at each end of the "umbilical cord". Any feedback on this would be much appreciated. (R. E., via email).

● Prior to last month's article on curing the audible buzz in the power transformer for this amplifier, the answer to your question would have been relatively simple: you can't use 18V transformers because that would increase the overall dissipation in each power amplifier.

Instead, our advice would have been to go for the 15V units. This will reduce the maximum available power output in each channel by a few watts before the onset of clipping but the logarithmic difference is only about 0.5dB which is hardly perceptible.

However, since that series of articles was published in 2007, more areas of Australia have now reduced their mains voltage to the official figure of 230VAC while some still have relatively high mains voltages of 250VAC or more. So before you can make a decision about which transformer to use, you really need to know what the average mains voltage is in your area. You need to measure it with a digital multimeter of known accuracy. If your mains voltage averages between 240V and 250V, you should use power transformers with 15V secondaries.

On the other hand, if your mains voltage is close to the 230VAC figure, you can pick the 18V + 18V units.

Note that the specified 16V transformer in the original design had an integral copper strap to reduce the internal hum field. That will not be important if you build the power supplies into separate enclosures but it will be a factor to consider if you build the power supply into each monoblock. On the other hand, the reduced load (half) should reduce the problem of winding buzz.

If you want to install the power supplies in separate enclosures, everything should be together. Do not under any circumstances have the rectifiers next to the transformers and the filter capacitor PCBs next to the power amplifiers, with long connecting leads between the two. If you do, the connecting leads will radiate lots of rectifier buzz which will inevitably become audible in your otherwise beautiful amplifiers.

around 240mA from a 12V supply. With a 1.3Ah battery, this would provide about five hours running without recharging, assuming no other current drain from any other load. If the bike does charge the battery while running, there should not be a problem with the small current drain.

Note that a more recent Fuel Mixture Display unit was published in SILICON CHIP in November 2008. It draws a similar current but is easier to build since there are less parts and it uses a single PCB rather than two.

The Bosch sensor is available from Tech Edge Pty Ltd (**http://wbo2.com**). The original sensor lead would be long enough. Note that the sensor wires must not be soldered. Instead, they must be crimped to any connector.

Frequency switch for electric vehicle

I have purchased the Frequency Switch kit (SILICON CHIP, June 2007) for an electric vehicle we are developing at our high school. I intend to utilise the kit to ensure the vehicle is in motion before the motor can be activated. I will use a Hall Effect IC to derive a signal from the rear wheel magnets to operate the Frequency Switch.

Can you please tell me the required voltage and current range for the input pulse signal? (A. B., Keilor, Vic).

● The input voltage needs to swing above about 1.84V from 0V to trigger the input of the LM2917. This threshold is set by the 10kΩ and 3.3kΩ resistors (across the 7.4V supply) that connect to pin 11 of IC1. The voltage should preferably rise to at least 2V for reliable triggering.

A Hall Effect output with a 10kΩ pull-up resistor to the 7.4V supply would trigger the LM2917. Note that the input current to pin 1 is insignificant and only becomes significant if the input rises above 16V and causes zener diode ZD1 to conduct. In that case, the current will be limited by the 10kΩ resistor between the input and the zener diode.

How to make CD copies from audio cassettes

Have you produced an article relating to taking the output (speaker) signals from a cassette player and recording to a home PC? I would like to use my computer to make CD copies of my audio cassettes. A DIY project perhaps?

There could be others with the same need and willing to build a device for this purpose. (N. A., via email).

● We published an article concerning transferring LPs to CD format in September 2006. This article is also suitable for transferring tape to CD format. Just disregard the section of the article concerning using an RIAA preamplifier for the recording of LP records and instead directly connect the cassette player output to the computer input. The section on using

the computer software to capture the audio and transfer it to CD is relevant to your application.

So for your application, no project is necessary – it is just a matter of directly capturing the audio from the cassette player on the computer.

Component substitute in the LED Dazzler

I do appreciate the box "Choosing Alternative Parts" in the LED Dazzler project article. Perhaps this can become a standard feature.

As it happens, I do have all the semiconductor parts to construct this project, except the LM285/385 2.5V voltage reference (IC2). I wonder whether I can use an LM336-2.5, which needs a bit more current to operate but is more widely available.

Thank you for another batch of great projects. (K. R., Craignish, Qld).

● Yes, you can use an LM336-2.5 for the LED Dazzler. If you do, decrease the value of the 270kΩ resistor feeding it to, say, 22kΩ. In the worst case, that will provide (12 - 2.5) ÷ 22,000 = 432µA which is adequate.

This will increase the current consumption when the low-battery cut-out is active to a little below 2mA but that is probably acceptable.

Running the LED Dazzler at 6V

A guy I know wants to use the LED Dazzler (SILICON CHIP, February 2011) on his bike, with a 6V battery. As a result, we may need to come up with a constant current source at 3.6V.

I did mention to him that they would no doubt be really really bright and possibly dangerous to other road users. (H. H., via email).

● It may be possible to get the LED Dazzler to run from a 6V supply but there would need to be some fairly extensive changes. You would need to replace the 78L12 regulator with a wire link and you would also need to use logic-level Mosfets. Some of the resistor values would need to be changed, eg, the 5.6kΩ resistor to the base of Q1 would need to be a lower value to give enough base current.

It would also be necessary to change the resistor network around IC1a to change the Vcc - 5.32V reference voltage since a 6V battery could easily drop below 5.32V and also the LM358's output current gets very weak below about 1V. That would probably require changes to the resistors around IC5 (eg, reducing the 8.2kΩ resistors that are driven by the reference voltage to a much lower value) to keep its inputs far enough below Vcc with the new reference voltage.

In short it isn't simple but it's probably possible. You could obviously only run a single white LED from it then. It would probably be fairly efficient in that configuration, possibly about 85%.

Fuel mixture reading fluctuates

I've bought and assembled a Fuel Mixture Display kit (SILICON CHIP, November 1995) from Jaycar. It does not give a stable output but continuously fluctuates, up to 13 times every 10s. It is annoying and I don't think it's supposed to do that.

Can you please advise me on what to do? (B. H., Rockhampton, Qld).

● A correctly operating sensor in conjunction with the car engine management computer will have the mixture cycling from rich to lean in rapid succession, possibly at between 1Hz and 10Hz. This is mentioned in the third column of the first page of the Mixture Display article.

The cycling of the sensor from rich to lean does not mean that the engine is running rich then lean in rapid succession. That's because the sensor is just responding to minute changes in oxygen level with large voltage excursions. The mixture remains stoichio-

One Farad Capacitors A Waste Of Money

I have a question regarding the large 1F caps as used in car audio systems, rated at 24V. In a decent car audio system, one or more 1F capacitors may be placed across the power rail. This is for when there is a peak load on the power rail which subsequently drops. The 1F cap(s) will provide their stored energy then, long enough for the vehicle power supply to "catch up" – ensuring there is no drop-out of sound. Or such is my understanding.

Another question is along similar lines but about computer power supplies. Consider a pretty ordinary computer PSU rated at 750W. It derives 12V at about 60A and other voltages (5V, 3.3V, etc) are derived from this. The specifications show the PSU has a hold-up time of >17ms and I would like to increase this.

My thought was to place a 1F 24V capacitor across the 12V rail via a low-value resistor. Will the idea behind car audio systems work for computer PSUs, with all their differences? A bullet-point in the promotional blurb states a benefit as: "Huge bulk capacitor for hold up time 17ms at full loading".

What is your opinion of doing this, seeing the PSU costs $125 and I would probably void my warranty if it failed? If you consider it viable, what resistance should be used? I would like to extend that 17ms figure and need a large PSU but not quite this large; it is for future upgrades and to leave a healthy margin.

I have not received a meaningful answer to this question from anyone I know. Can you resolve this issue for me?

A 1.2Ω series resistor to the cap will current-limit to 10A and I might consider even a 2.2Ω resistor (though it would be quite large). A high-power diode in parallel with the resistor (cathode to the +12V rail) would allow an outflow of current well in excess of the resistor limiting current but you would lose 0.7-1.0V (minus whatever the resistor provides), depending on the diode chosen. Is this a sound proposition? (B. C., Ashfield, NSW).

● We regard 1F (one Farad) capacitors in car sound systems as being a good gimmick to separate the customers from their dollars. A car battery is the best and cheapest energy storage medium you can find – far better than 1F capacitors. Pretty much the same comment applies to any use involving a computer power supply.

If you don't believe that, then a few calculations on how much difference adding a 1F capacitor will make to the hold-up time will show that it's negligible.

Next month in Silicon Chip: June 2011

Marantz CD6003 CD player review

If you're sick of playing CDs through a DVD player and are considering upgrading to a quality CD player, this review will be of considerable interest. It is a complex, high-performance machine with pitch control and a USB input so it can play MP3 and other music file formats.

VersaTimer/Switch

This highly flexible circuit uses a PIC micro and a choice of latching relays to provide a timer or battery cut-out function with very low current drain. It can be used in a variety of applications where very low current drain is paramount.

12/24V 20A Speed Controller

This is an upgrade of the very popular speed control published in the June 1997 issue. It incorporates a number of requested improvements, including full-range speed control and low battery protection.

Note: these features are in the process of preparation for publication and barring unforeseen circumstances, will be in the issue.

ON-SALE: Wednesday, 27th May 2011

metric, even with this cycling.

The movement of LEDs therefore shows that the car is running correctly at stoichiometric mixture and is just reflecting the action of the sensor to very small changes in mixture. Under trailing throttle, the mixture reading may show just the lean LED and under heavy throttle may show just the rich LED.

Alternatively, with some cars, the mixture always remains at stoichiometric (ie, constant LED cycling from rich to lean). Or it can lean out with cruising throttle.

You can prevent the LEDs from constantly cycling so that the display shows only the average level. This is done by connecting a 1MΩ resistor in series with the sensor signal and the pin 5 input of the LM3914 (IC1) on the Fuel Mixture Display. A 1µF capacitor is then connected with its positive side to pin 5 and negative side to pin 4 (0V) of the LM3915.

As far as we are aware, the Jaycar kit does actually have a series resistor to pin 5 (not shown on the November 1995 article) that can be changed to a value of 1MΩ.

Driving a shaker for vibration testing

I intend using the Ultra-Low Distortion 135W RMS Amplifier Module (Silicon Chip, August 2008) to drive a vibration unit which has a 1Ω coil resistance. I have a 4Ω-to-1Ω 2kVA matching transformer.

As I will be always working into a 4Ω load, I thought it would be best to derate the power supply to about 30V + 30V AC. As a result, I may need to change some of the current source resistors.

The unit I'm driving is similar to this: **http://www.etssolution.com/shaker-l215m.php**

Any suggestions would be appreciated. (W. W., Christchurch, NZ).

- The amplifier can drive a 4Ω load without having to reduce the supply voltage. The main problem with driving a transformer is the amplifier's DC residual output voltage, typically around 50mV or less. While the nominal impedance of the set-up may be 4Ω, the transformer itself will have a very low DC resistance in its primary winding (and its secondary, for that matter).

If the DC resistance is less than 1Ω and the amplifier's DC offset is 50mV, then you will have 50mA flowing in the transformer primary and this will cause extra heating of the amplifier output stage. So the first point to check is the amplifier's DC offset. If it is high, you may have a problem.

Ideally a 1N5404 diode should be placed between the amplifier's output and each supply rail for inductive clamping. The diode to the positive supply has the anode to the amplifier's output. The diode to the negative supply has the anode to the negative supply and the cathode to the amplifier's output. SC

Notes & Errata

DAB+ Tuner (November 2010): on page 77, under preliminary checks, step 3 has REG4 and REG5 mixed up. The LM317T is REG4 while the LM3940 regulators are REG3 and REG5.

WARNING!

Silicon Chip magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely.

Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of Silicon Chip magazine.

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